Electronic Services - Los Angeles
M12917X

Operating and Service Manual

GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATION
1200 KONA DRIVE
COMPTON, CA 90220
(213) 642-5317

GOULD

GOULD BRUSH

MANUAL PART NO.
15-806327-50

BRUSH 220 RECORDER
ALL MODELS

PRINTED 1/17/78
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Gould Inc., Instruments Division
3631 Perkins Avenue, Cleveland, Ohio 44114

39th PRINTING
PRINTED IN U.S.A.

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Brush 220 Recorder is a completely self-contained, portable, lightweight two-channel analog recorder.

The recorder features a pen-position servo system, based on a frictionless transduer, assuring extreme accuracy. Traces are clear, crisp and uniform. This writing system of pressurized ink puts the traces into the paper, not on it. The ink is contained in a disposable plastic cartridge which can be replaced in minutes. Pen motion is rectilinear.

Recording range extends from one millivolt to 500 volts a-c, peak-to-peak and one millivolt to ±250 volts d-c. Input is differential balanced-to-ground, or single-ended by use of ground strap. Frequency response is flat from d-c to 100 Hz at ten divisions, with full scale response at 40 Hz (±2% full scale).

Full functional control, including 13-step attenuation, intermediate sensitivity, and pen positioning is provided on the front panel for each analog channel. Adjustable electronic pen limiters on amplifier prevent analog pen damage from off-scale signals. Two event markers are standard on left and right-hand margins. A third event marker may be added between analog channels. Convenient jacks on rear panel permit activation of markers from an external switch closure.

Two series of Brush 220's are standard. One has four chart speeds of 1, 5, 25 and 125 millimeters per second, and the other has eight chart speeds of 1, 5, 25 and 125 millimeters per minute or millimeters per second (Figure 1-1). All chart speeds are electrically selected by pushbuttons.

A version of the Brush 220 is also available for the telephone industry with all standard features plus special remote control facilities and a 1/10 second interval timer (Figures 1-2 and 1-3).

Chart tracking error is less than 0.025 of an inch in 10 feet after stabilization at high speed. Chart capacity is 275 feet with high-contrast Kromekote and 400 feet with reproducible paper.

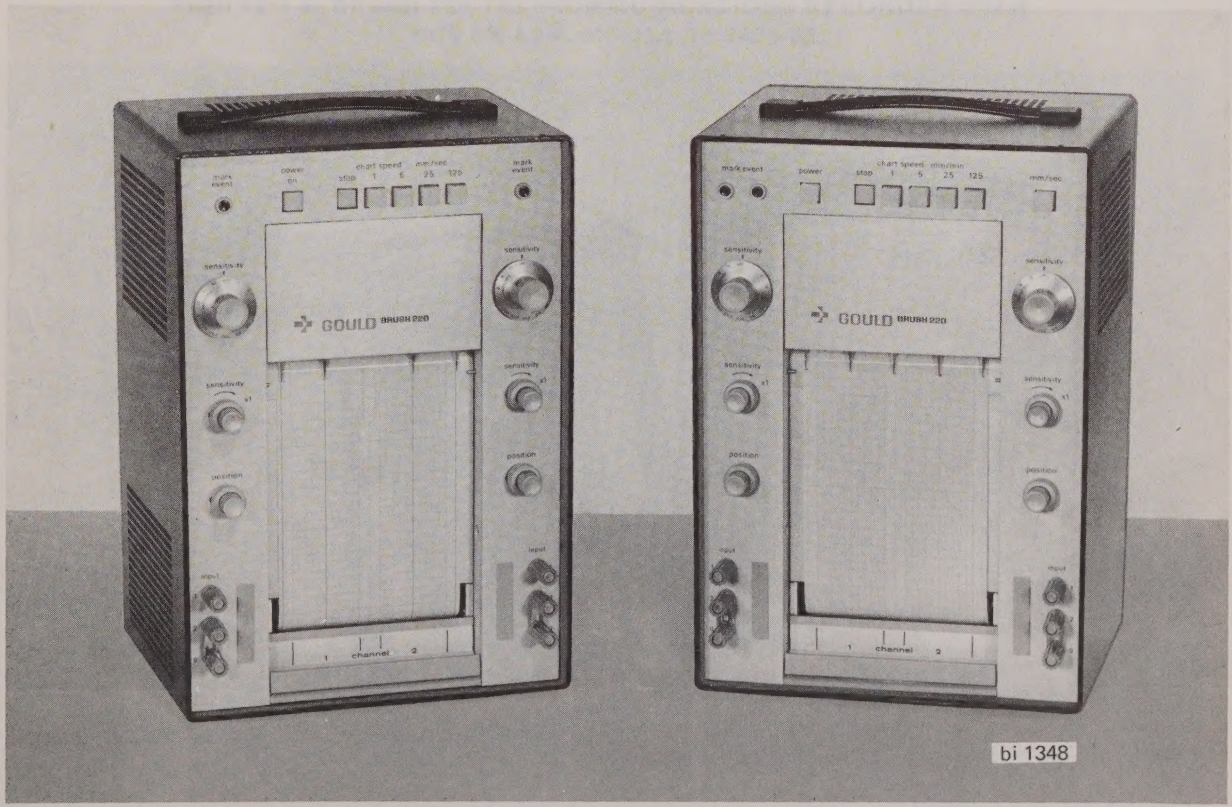

FIGURE 1-1 BRUSH 220 RECORDERS: FOUR SPEED AND EIGHT SPEED

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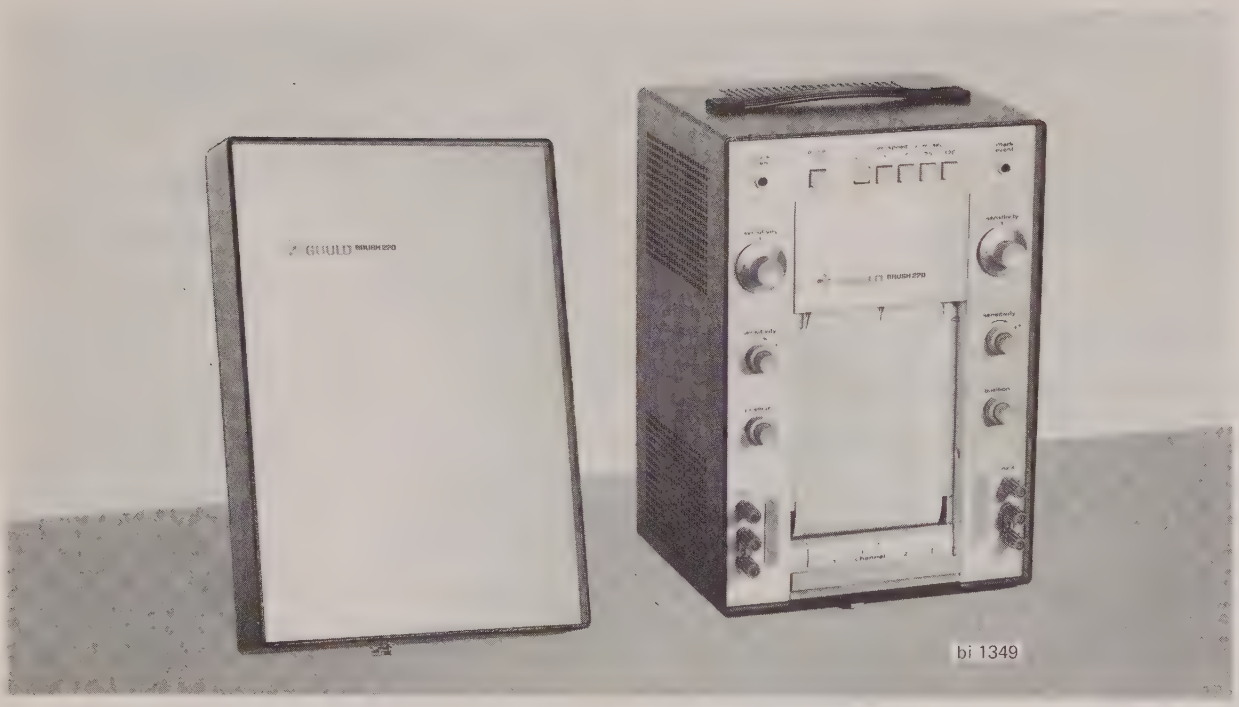


FIGURE 1-2 BRUSH 220 TELECOMMUNICATIONS RECORDER WITH COVER ASM, MODEL 11-6404-30

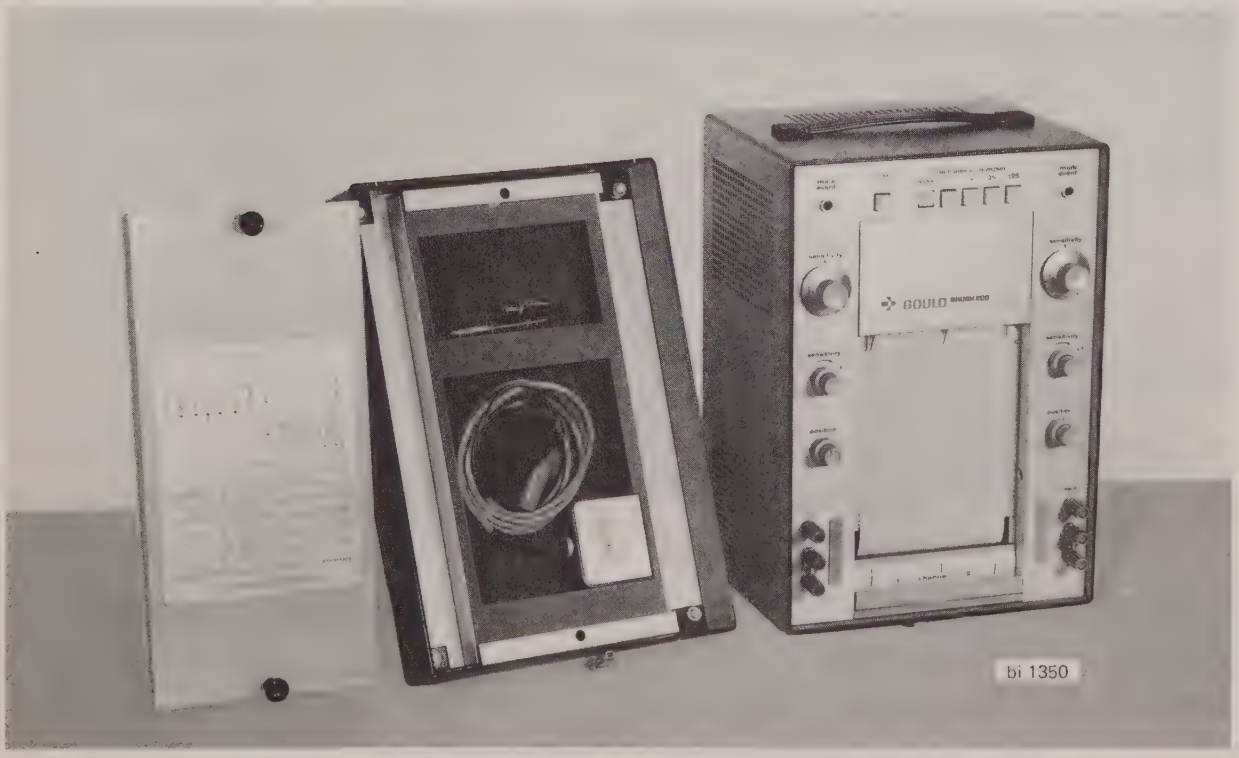


FIGURE 1-3 TELECOMMUNICATIONS RECORDER WITH COVER ASM MODEL 11-6404-30 WITH ACCESSORIES SHOWN

1.2 SPECIFICATIONS

This paragraph lists the specifications and data pertinent to the Brush 220 Recorder.

a. General

Number of Channels	2 Analog, 2 Event
Channel Width	40 mm, 50 divisions per channel
Trace Presentation	Rectilinear
Trace Width	0.01 inch nominal
Writing Method	Pressurized fluid (U.S. Patent 3,054,109)
Writing Fluid Capacity	1 oz; sufficient for one year of normal recording
Chart Description	4.3 inches wide—two 40mm grids graduated in 50 divisions across span. Graduated 1mm increments on time axis. Right and left event marker channels
Chart Capacity	275 feet – high contrast 400 feet – reproducible
Chart Speeds	1, 5, 25, 125 millimeters per second and STOP; 1, 5, 25, 125 millimeters per minute or per second and STOP
Chart Speed Accuracy	±0.25%
Operating Temperature	0°C to +55°C. Recorder will remain within specification over range of ±10°C from temperature at calibration
Storage Temperature	−40°C to +85°C
Principle Dimensions	Refer to Figure 1-4
Weight	25 pounds

b. Electrical

Sensitivity	1 mv/div to 10 volts/div
Measurement Range	1 millivolt per chart division to 500 volts d-c full scale (50 chart divisions)
Input Circuit	Differential, balanced-to-ground
Input Impedance	10 megohms balanced, 5 meghoms each terminal to ground
Signal Input	
In-Phase Rejection	60 dB at 60 Hz with maximum source unbalance of one kilohm at one mv/div sensitivity setting (decreasing on higher sensitivity settings)
Maximum Signal Input	500 volts d-c, or peak-to-peak (either input to ground)

Maximum Common Mode Voltage . . . . . 10,000 times the VOLTS/DIV sensitivity up to a maximum of 500 volts

ATTENUATOR SETTING	MAX.COMMON-MODE VOLTAGE
1 mV/div	10V d-c
2 mV/div	20V d-c
5 mV/div	50V d-c
10 mV/div	100V d-c
20 mV/div	200V d-c
all others	500V d-c

Non-Linearity . . . . . 0.5% full scale d-c

Frequency Response . . . . . 50 div ±1 div d-c to 40 Hz
10 div ±1 div d-c to 100 Hz
3 dB down at 125 Hz (Refer to Figure 1-6)

Stability (after 15-minute warm-up and excluding paperdrift)

(Zero with respect to)

Time . . . . . ±0.1 div for 8 hours

Temperature . . . . . ±0.1 div per °C, 25°C ±10°C

Line Voltage . . . . . ±0.05 division, ±10% line variation

(Gain with respect to)

Time . . . . . ±0.1% per 8 hours

Temperature . . . . . ±0.05% per °C, 25°C ±10°C

Line Voltage . . . . . ±0.05% per volt, ±10% line variation

Power Input (a-c)

15-6327-50, -51, -57 . . . . . 115 volts ±10% 60 Hz
15-6327-55 . . . . . 115 volts ±10% 50 Hz
15-6327-56,-58 . . . . . 230 volts ±10% 50 Hz

Power Consumption . . . . . 160 watts; 269 volt-amperes at 115 volts (all models)

1.3 SUPPLIES AND ACCESSORIES

a. Supplies

Chart Paper

High-Contrast, Kromekote (275 feet) 1mm time line 11-2923-32

Reproducible (400 feet) 11-2923-43

Analog Pen 11-2823-33

Extended Life Analog Pen 11-2823-34

Event Marker Pen 11-2873-20

Ink Cartridge (1 oz) 11-2730-01

Pen Replacement Wrench (Multiple Splined) 1-120922-2

Pen Pressure Adjustment Wrench (Multiple Splined) 1-120922-18

Gram Gage (Pen Pressure) 240601-910

Band Replacement Tool 341409-915

Band Replacement Wrench (Multiple Splined) 1-120922-3

Band Replacement Wrench (Hex) 245218-5

b. Accessories

Starter Kit 11-6250-00

Consists of:

Chart Paper (12 rolls) 11-2923-32
Gram Gage 240601-910
Pen Pressure Wrench 1-120922-18
Pen Replacement Wrench 1-120922-2
Dust Cover 465971

Replacement Kit 11-6251-00

Consists of:

Chart Paper (12 rolls) 11-2923-32
Analog Pens (2) 11-2823-33
Event Marker Pens (2) 11-2873-20
Ink Cartridge (1 oz) 11-2730-01

Rack Mounting Kit 11-1202-08

Internal One-Second Timer 11-6101-21

Chart Takeup 11-6402-03

Interchannel Event Marker Kit 11-6221-00

Dust Cover 465971

AC-DC Converter 11-6403-00

Shipping case (aluminum) 367181
Case insert 468001

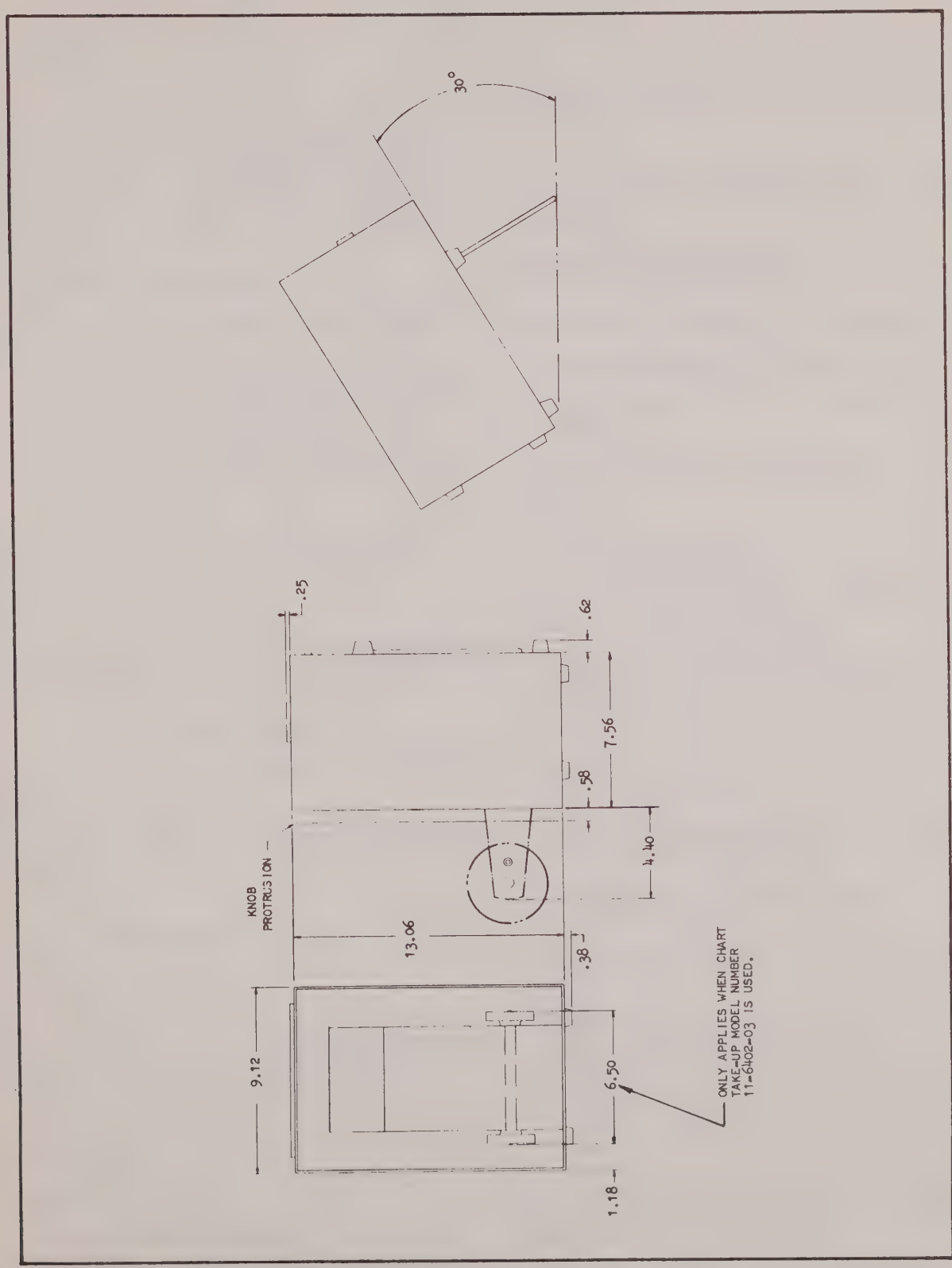


FIGURE 1-4 BRUSH 220 RECORDERS -- OUTLINE DIMENSIONS

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the inspection checks to be performed upon receipt of the Brush 220 and details power requirements and signal connections. In addition, this section describes and illustrates installation of the Chart Takeup, Interchannel Event Marker, One-Second Timer, and Rack Mounting Kit.

2.2 INCOMING INSPECTION

Perform the following procedures before operating the recorder.

1. Visually inspect unit for damage that may have occurred during shipment. Refer to warranty sheet in case of damage.

2. Remove packing material and tape from recorder.

NOTE: Do not attempt to operate this equipment before completing Section III, Operation.

2.3 POWER REQUIREMENTS

Listed below are the voltage, frequency, and power requirements for the various models of the Brush 220 Recorder.

Model No.	Power Source
15-6327-50, 15-6327-51, 15-6327-57	115 volts a-c, ±10%, 60Hz, 160 watts
15-6327-55	115 volts a-c, ±10%, 50Hz, 160 watts
15-6327-56, 15-6327-58	230 volts a-c, ±10%, 50Hz, 160 watts

2.4 SIGNAL CONNECTIONS

a. Drive Amplifier Input Signal

Connect signal to INPUT 1 and 2 terminals on front panel. For single-ended input, connect ground strap to terminal 2. For balanced or double-ended input, disconnect ground strap.

NOTE: A positive input to pin 1 will cause the pen to deflect to the left.

b. Event Marker Signals

The event markers are actuated by pushbutton switches located on front panel. The left marker pen deflects to the left, right marker pen deflects to the right. Event markers may also be actuated by external switch closure (short) across terminals located on rear panel.

NOTE: Resistance of each event marker coil is 600 ohms and has −32 volts d-c connected from an internal source.

2.5 CHART TAKEUP INSTALLATION (MODEL 11-6402-03)

Refer to Figure 2-1 and perform the following:

1. Disconnect recorder from power source.

2. Remove recorder from case (refer to Para. 4.3a)

3. Remove plastic caps covering slots in front panel.

4. Remove ground straps from channel input terminals and set aside.

5. Remove screw and remove shield can from rear of channel 1 input terminals.

6. Loosen nut, on rear of middle binding post on channel 1 input terminals, allowing shield can mounting bracket to rotate free on binding post.

7. Position chart takeup on front panel with drive belt on left side.

8. Attach chart takeup to front panel with four screws and four lockwashers.

9. Slide pulley onto pressure roller shaft and secure with cotter pin.

10. Position chart takeup drive belt around pulley.

11. Position shield can mounting bracket and tighten nut on middle binding post.

12. Attach shield can to mounting bracket at rear of channel 1 input terminals with screw.

13. Replace ground strap.

NOTE: The ground strap should be positioned so that when disconnected from middle binding post it will swing away from chart takeup.

14. Install recorder in case (refer to Para. 4.3b).

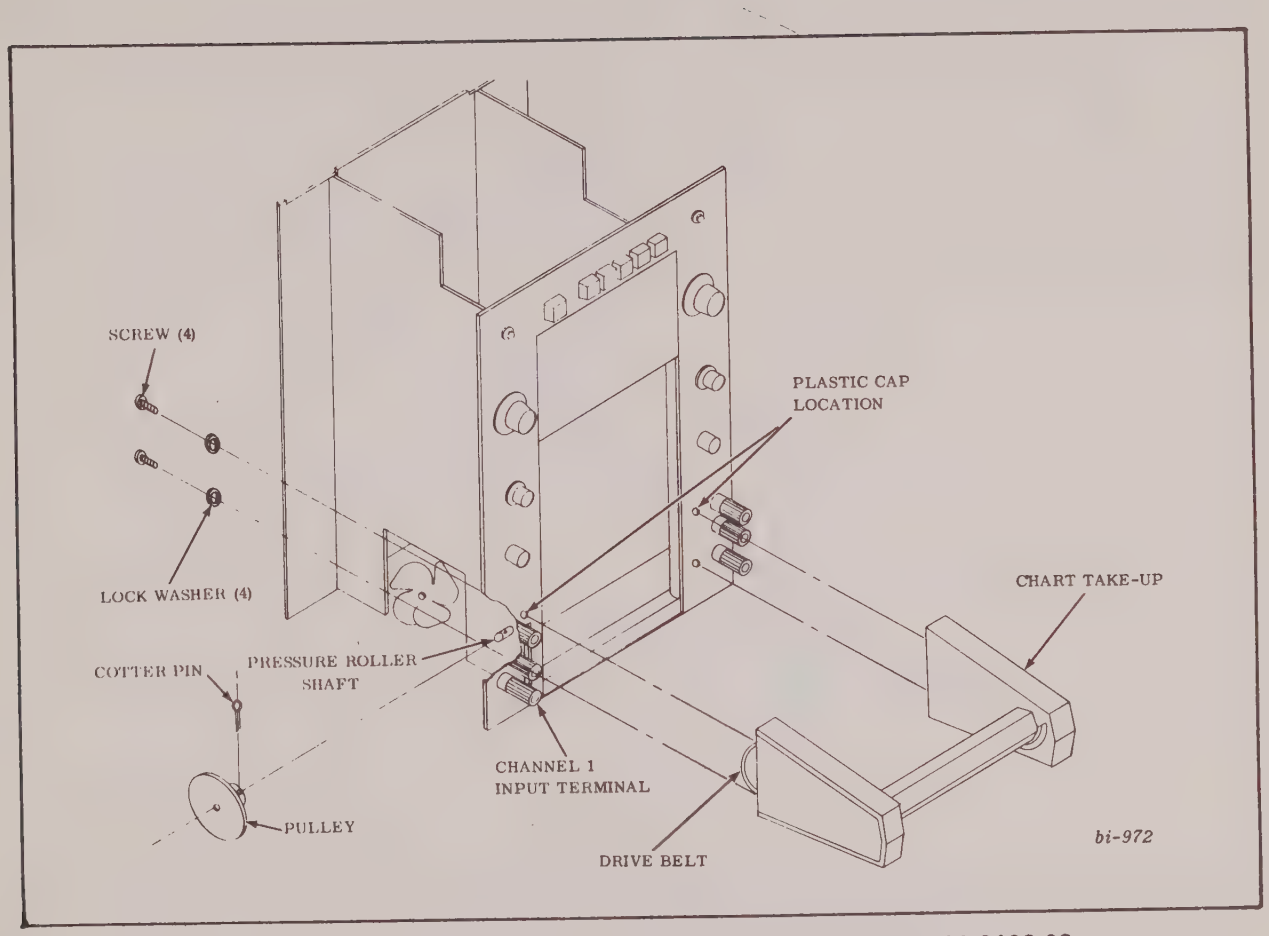


FIGURE 2-1 INSTALLATION OF CHART TAKEUP, MODEL 11-6402-03

2.6 INTERCHANNEL EVENT MARKER INSTALLATION (MODEL 11-6221-00)

Refer to Figures 2-2 and 4-5 and perform the following:

1. Disconnect recorder from power source.
2. Remove recorder from case (refer to Para. 4.3).
3. Remove pen access cover.
4. Secure Event Marker to penmotor mounting bar with self-tapping screws.
5. Connect black lead from Event Marker to terminal 2 and blue lead to terminal 3 of terminal board TB-302, at rear of recorder.
6. Install jacks into existing holes in rear panel.
7. Attach capacitor across jacks (do NOT solder).
8. Solder one end of 10-inch lead to one end of capacitor and jack as shown.
9. Connect other end of 10-inch lead to terminal 3 of terminal board TB-302.
10. Solder one end of 4-inch lead to capacitor and jack as shown.
11. Solder other end of 4-inch lead to existing jack as shown.
12. Install pen on Event Marker (refer to Para. 4.5).
13. Remove cap from manifold nipple and connect ink tubing from pen to ink manifold nipple.

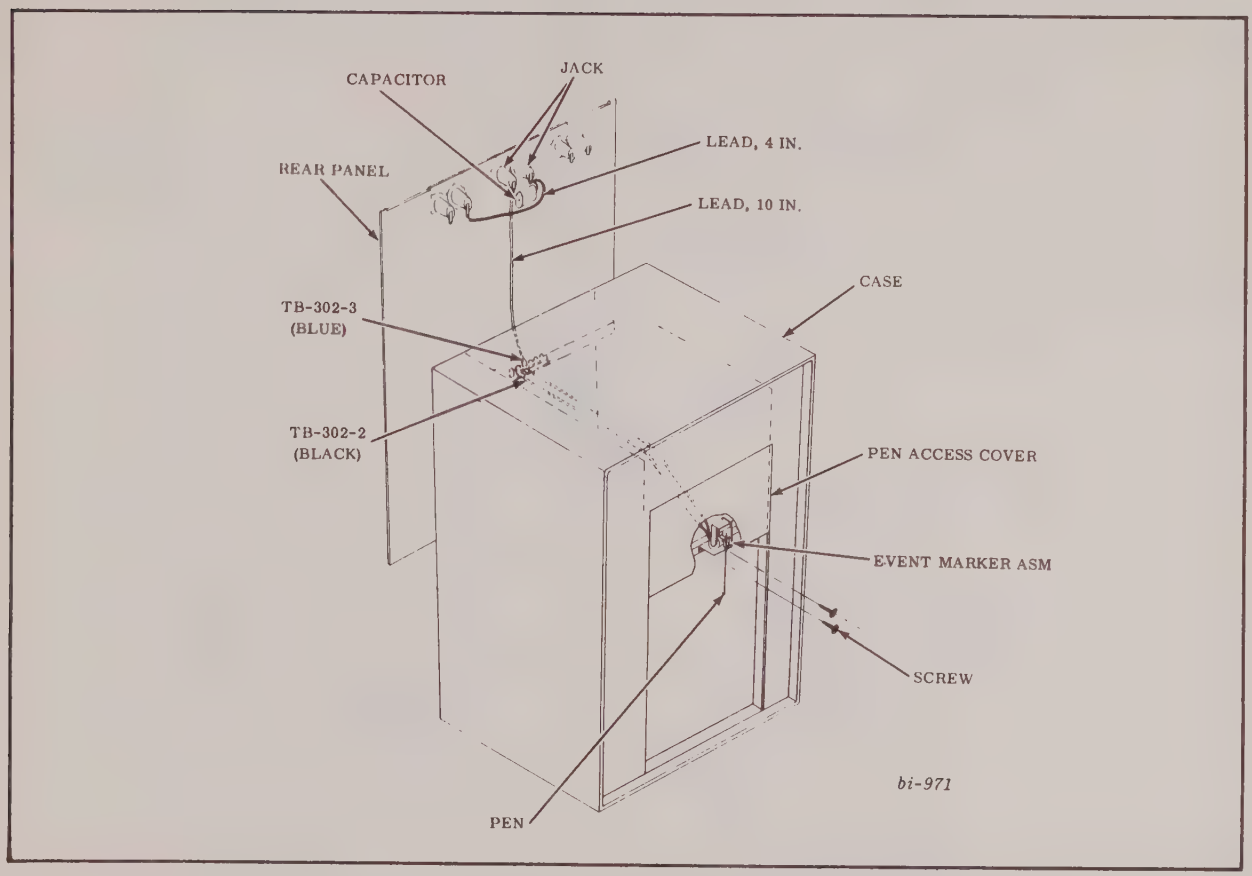


FIGURE 2-2 INSTALLATION OF INTERCHANNEL EVENT MARKER, MODEL 11-6221-00

14. Turn ink valve control clockwise to ON position.

15. Check and adjust pen pressure (Para. 4.8).

16. Lap pen if required (Para. 4.9).

17. Install recorder in case.

18. Replace pen access cover.

2.7 ONE-SECOND TIMER INSTALLATION (MODEL 11-6101-21)

Refer to Figure 2-3 and perform the following:

1. Disconnect recorder from power source.

2. Remove recorder from case (refer to Para. 4.3).

3. Remove four screws securing rear panel to recorder and move panel to one side to allow access to inside of rear panel.

CAUTION: USE CARE WHEN MOVING REAR PANEL SO NOT TO BREAK ATTACHING LEADS.

4. Relieve pressure on ink cartridge (refer to Para. 4.10, step 3).

NOTE: Relieving pressure on cartridge will prevent ink escaping if tubing is accidently pulled from cartridge.

5. Position timer on inside of rear panel and attach with two screws.

6. Position timer ON-OFF switch on lower left-hand corner of rear panel and attach with two screws and two lock washers.

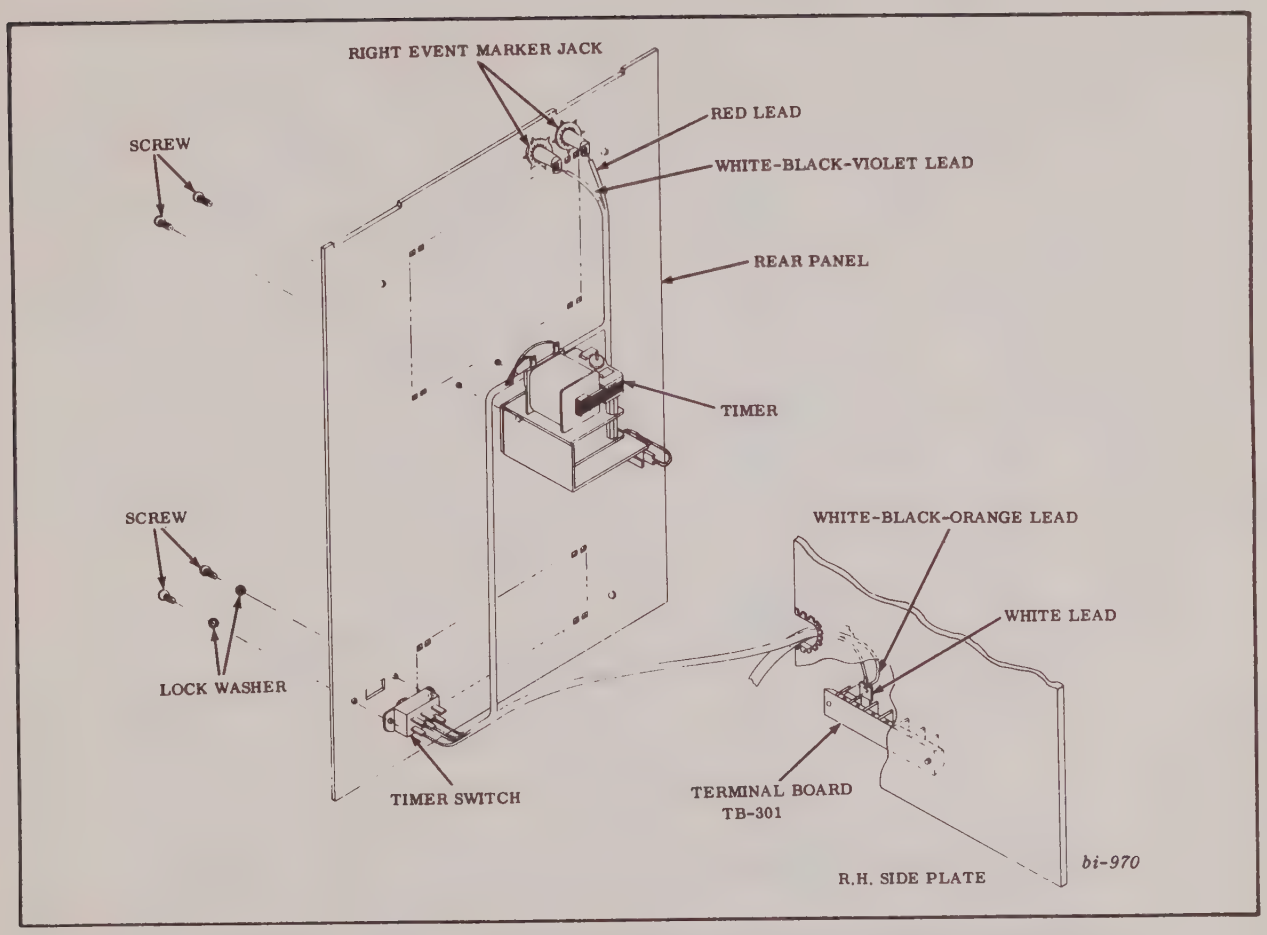


FIGURE 2-3 INSTALLATION OF ONE-SECOND TIMER, MODEL 11-6101-21

7. Solder red and white/black/violet leads to right event marker jacks.

8. Connect white lead to terminal 5 and white/black/orange lead to terminal 6 on terminal board TB-301 on the right-hand side plate.

9. Apply pressure to ink cartridge (refer to Para. 4.10, step 4).

10. Position rear panel on rear of recorder and secure with four screws.

11. Install recorder in case.

2.8 RACK MOUNTING INSTALLATION

The Brush 220 Recorder may be rack mounted in a standard 19-inch RETMA cabinet using Rack Mounting Kit, Model 11-1202-08

a. Installation

Refer to Figure 2-4 and perform the following:

1. Remove four screw and rubber feet from bottom of recorder.

2. Attach support bracket to bottom of recorder with four screws and lock washers.

3. Attach two bottom nut bars to cabinet front rails at desired height using two screws and spacers.

4. Position right-hand hanger behind nut bar and attach to front rail with two screws.

5. Position support hanger against rear rail and attach with two screws.

6. Align slotted holes on hanger with holes on support and install two screws.

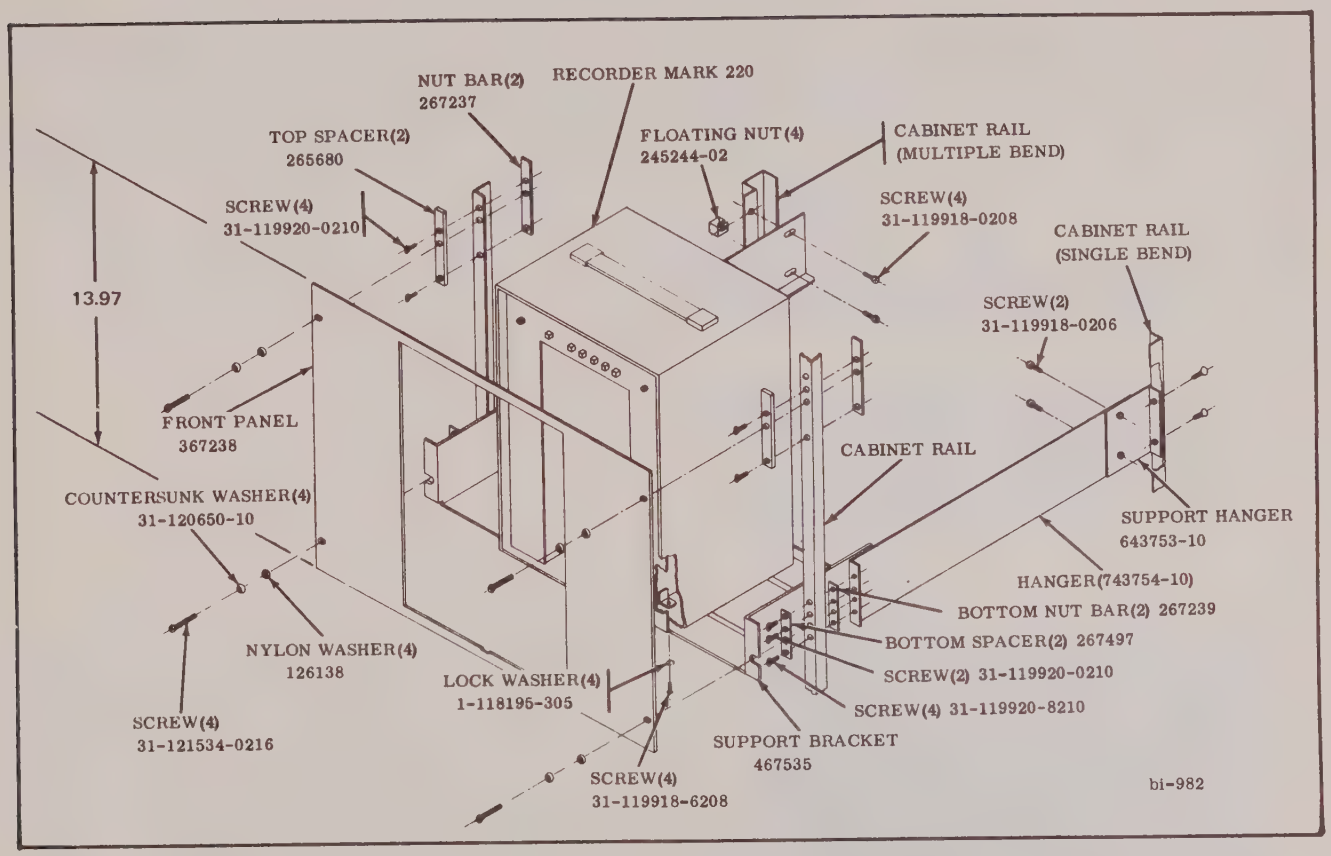


FIGURE 2-4 INSTALLATION OF RACK MOUNTING KIT, MODEL 11-1202-08

7. Perform steps 4, 5, and 6 to mount left-hand hanger.

NOTE: The above procedure is used when the rear mounting is a single-bend cabinet rail. If the rear mounting is a multiple bend cabinet rail, the support hanger is not required. Instead, slide two floating nuts, onto the rear rail, position hanger against rail, and attach with two screws as shown on left rear rail in Figure 2-4.

8. Attach two top nut bars to cabinet front rails using four screws and spacer.

9. Slide support bracket with recorder attached onto hangers.

10. Position front panel around recorder and attach to front rails with four screws, nylon washers, and countersunk washers.

b. Removal

1. Remove four screws and attaching hardware and remove front panel.

2. Remove four screws and lock washers from support bracket and remove recorder.

SECTION III

OPERATION

3.1 GENERAL

This section describes and illustrates the controls on the Brush 220 Recorder and also provides instructions for proper operation.

3.2 FRONT PANEL CONTROLS

NOTE: Item numbers listed below correspond to circled numbers in Figure 3-1.

Item	Control	Description
1	POWER ON	Controls a-c power to recorder. Depress button to turn recorder ON or OFF. An internal lamp illuminates the pushbutton when the recorder is on.
2	CHART SPEED	Permits selection of four chart speeds and STOP. When in STOP position chart drive is off, and pens will not respond to input signals. Depressing any chart speed button will activate the chart drive at the selected speed. Chart speeds may be changed while chart drive is running.

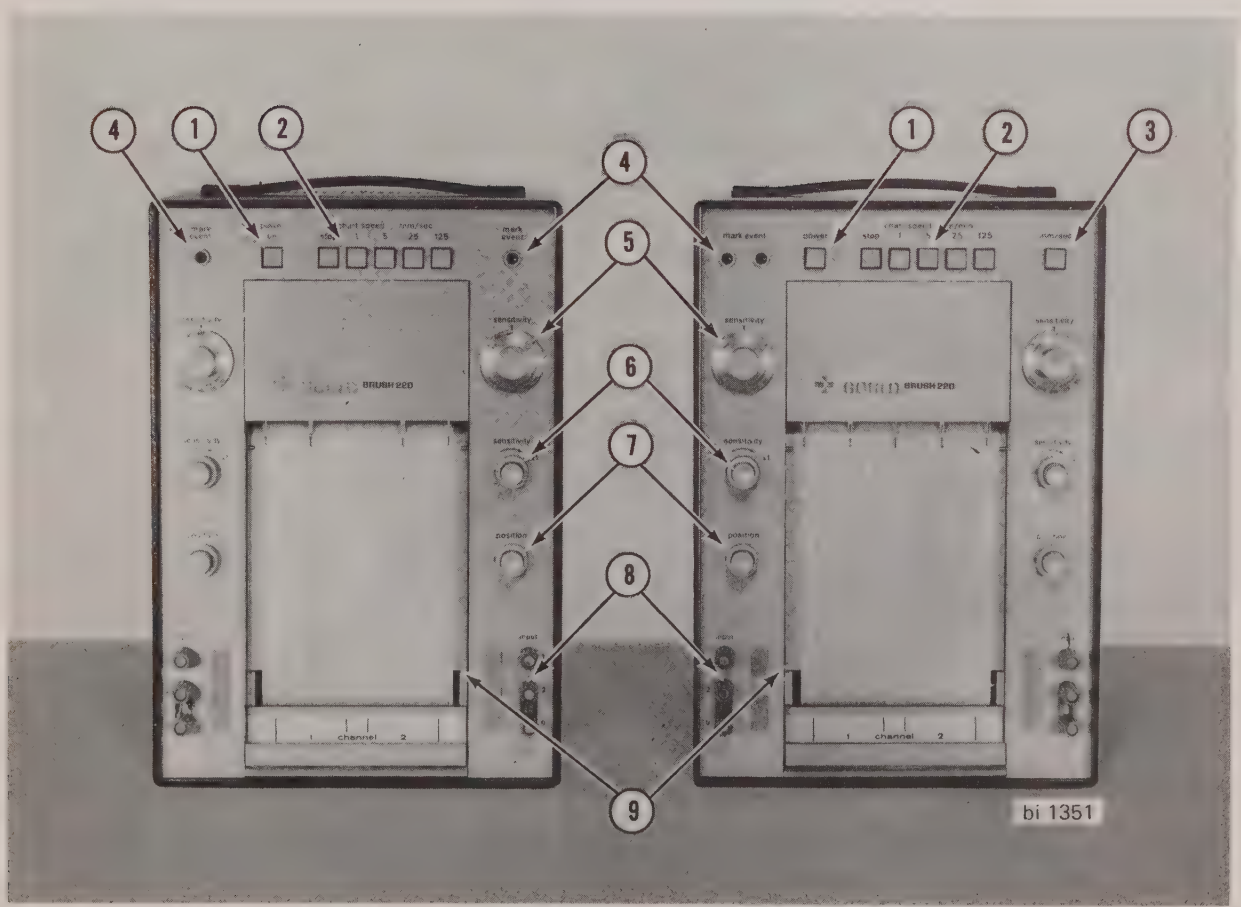


FIGURE 3-1 BRUSH 220 RECORDERS – FRONT PANEL CONTROLS

3	MM/SEC (Eight speed only) . . .	When depressed, chart speeds are in millimeters per second. This button may be depressed at any time while the chart drive is running.
4	MARK EVENT	Two momentary switches permit manual marking of an event. When left MARK EVENT button is depressed the left event marker pen will deflect to the left. When the right MARK EVENT button is depressed the right event marker pen will deflect to the right. **NOTE: The event marker pens will remain deflected until the MARK EVENT button is released.**
5	SENSITIVITY	Provides 13-step attenuation of input signal from one millivolt per division to ten volts per division, and OFF.
6	SENSITIVITY X1	Provides intermediate sensitivities between the fixed settings of the stepped sensitivity control. When in the full clockwise x1 (detent) position, the sensitivity is fixed as indicated on the stepped sensitivity control. When rotated counterclockwise, the sensitivity is less than indicated on the stepped sensitivity control to a maximum ratio of 2.5 to 1. This control is fitted with a locking nut to prevent inadvertent turning. **NOTE: This is a variable control, but not calibrated.**
7	POSITION	Permits pen positioning anywhere within the channel and allows either edge of channel, or any point between to be used as zero signal position. This control is fitted with a locking nut to prevent inadvertent turning.
8	Signal Input Terminals	Three input terminals are provided for each channel. Ground strap is removable to provide balanced or floating input. Input is single-ended with ground strap connected.
9	Writing Table	Complete assembly consisting of table, writing bar and paper supply shaft. To gain access to the paper supply, pull out on pull bar and swing table up. To close, swing table down into position and push on pull bar until table snaps in place. **NOTE: Writing table must be completely closed or recorder will not operate. Recorder is equipped with an interlock circuit which prevents operation when writing table is not properly closed or when paper supply is exhausted.**

3.3 REAR PANEL

NOTE: Item numbers listed below correspond to circled numbers in Figure 3-2.

1 Event Marker Right . . . . . Two jacks which permit actuation of right event marker by external switch closure. Placing a short between these two jacks will deflect right event marker pen to right (refer to Para. 2.4b).

Pen will remain deflected until short is removed.

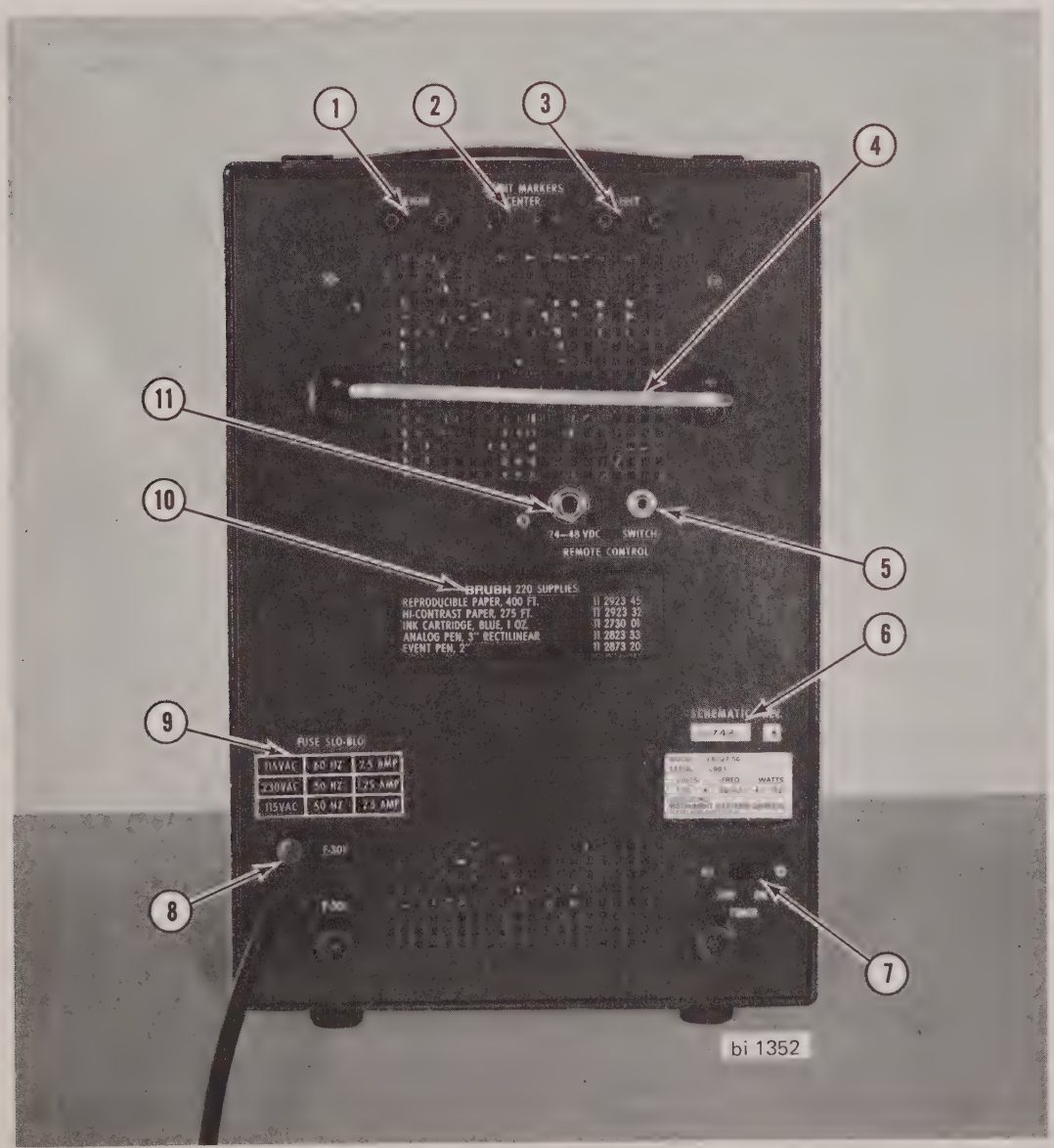


FIGURE 3-2 REAR PANEL – BRUSH 220 RECORDER.

2 Center Event Marker Input (optional) . . .	Two jacks which permit actuation of center event marker from external switch closure.
3 Event Marker Left	Two jacks which permit actuation of left event marker from an external switch closure. Placing a short between these two jacks will deflect the left event marker pen to the left (refer to Para. 2.4b). Pen will remain deflected until short is removed.
4 Tilt Support	Permits operation of recorder in 30 degree reclined position. Bar swings out and snaps in place.
5 SWITCH Remote Control . . . . . (Telecommunications only)	With plug (supplied with the recorder) inserted, the recorder chart drive may be started by shorting (external switch closure) this plug. **NOTE: This jack performs the same functions as the STOP switch on the front panel.**
6 Schematic Number	This schematic number, with the revision letter indicated, must correspond with the number and revision letter of the schematic found at the rear of this manual.
7 Internal Timer (optional)	Provides internal one-second pulses to actuate right event marker. When in the ON position, right event marker will be actuated by an internal timer at the rate of one pulse per second. When in the OFF position, the internal timer is inoperative. **NOTE: Internal 1/10 second timer is standard on Model 15-6327-51 Telecommunications Recorder.**
8 Fuse	Line fuse, protects the recorder from damage if a serious malfunction should occur.
9 Fuse Table	A list of factory recommended ratings for fuses for various a-c power source. **CAUTION: THIS LIST DOES NOT IMPLY THAT THE RECORDER WILL OPERATE AT ALL THE INPUT SOURCES LISTED. THE RECORDER CAN ONLY BE OPERATED FROM A–C POWER SOURCE AS INDICATED BY THE MODEL NUMBER. REFER TO PARAGRAPH 2.3 FOR THE CORRECT A-C SOURCE FOR THE MODEL BEING USED.**
10 Supplies List	A list of supplies by correct model number permanently silkscreened on the rear of recorder. Refer to this list when re-ordering supplies.
11 24-28 VDC Remote Control . . . . . (Telecommunications only)	With plug (supplied with recorder) inserted, the recorder chart drive may be started by applying 24 to 48 volts d-c to the plug. This jack overrides the switch jack. **NOTE: This jack performs the same functions as the STOP switch on the front panel.**

3.4 RECORDER SET-UP AND OPERATION

CAUTION: CHECK TO BE SURE ALL PROCEDURES IN SECTION II, INSTALLATION, HAVE BEEN PERFORMED.

When preparing the Brush 220 Recorder for operation, be sure to observe all of the following steps:

1. With unit disconnected, open writing table by pulling up on pull bar (see Figure 3-1) and be sure adequate paper for operation is on supply roll, and that it is properly threaded. (See threading diagram on side of writing table). If paper supply is exhausted or improperly threaded, refer to Para. 4.2 for complete instructions for changing chart paper. Close writing table firmly.

2. Connect unit to proper voltage and frequency as indicated on unit nameplate.

3. Depress POWER switch and observe that the POWER switch button is illuminated.

4. Depress 5 MM/SEC chart speed button and operate recorder to insure good ink flow on all channels. If no writing is present after first one foot of paper, refer to Para. 4.8 and check ink cartridge for adequate ink.

5. Set SENSITIVITY control to OFF position.

6. Turn SENSITIVITY X1 control to full clockwise position (detent) and secure with locking knob.

7. Position pen at exact chart center or any other position desired as signal - zero position with the POSITION control. Lock knob in this position.

8. Switch SENSITIVITY control to a range that will permit maximum pen deflection without going beyond chart edge.

9. Chart deflection will be proportional to the SENSITIVITY control setting for the voltage being recorded.

10. Select a chart speed that will best display the signal with respect to the frequency of the signal.

11. Unit is now ready for operation.

NOTE: Primary power is removed from recorder by a paper interlock switch when paper supply is exhausted. Because of the necessity of keeping paper under pens at all times, some unused paper will remain on the roll.

3.5 OPERATION WITH BRUSH PREAMPLIFIERS AND COUPLERS

When using this recorder in conjunction with any Brush preamplifier or coupler, proceed as follows to insure proper operation.

1. Set recorder SENSITIVITY to OFF position.

2. Adjust recorder POSITION control to position pen at exact chart center and lock knob.

3. Check that recorder vernier SENSITIVITY X1 control is in the detent position, and lock knob.

4. Set recorder SENSITIVITY to 100 MV/DIV.

5. Connect preamplifier output to recorder in such as way that turning the preamplifier POSITION control clockwise will move the pen to the right. The recorder ground strap may have to be disconnected, depending on the output polarity of the preamplifier or coupler.

3.6 TELECOMMUNICATIONS RECORDER AC-DC CONVERTER

An AC-DC Converter, Model 11-6403-00 is supplied with the Model 15-6327-51 Telecommunications recorder. When properly attached to the recorder input terminals, this unit converts AC signals to equivalent DC levels. The converter is applicable in the frequency range of 700 Hz to 100K Hz.

SECTION IV

MAINTENANCE

4.1 GENERAL

This section describes and illustrates removal, installation, and adjustment procedures that can normally be performed by the operator. All pictures are of the four speed version.

4.2 CHANGING CHART PAPER

This paragraph describes and illustrates the procedures for changing the chart paper.

NOTE: The last 50 feet of all Brush chart paper is identified by a blue line moving from right edge to left edge. When blue line crosses chart center, approximately 25 feet of paper remain.

a. Removal

1. Press chart speed STOP button.
2. Turn recorder off.
3. Grasp pull bar (Fig. 4-1) on bottom of writing table and pull out and up to place writing table in open position.

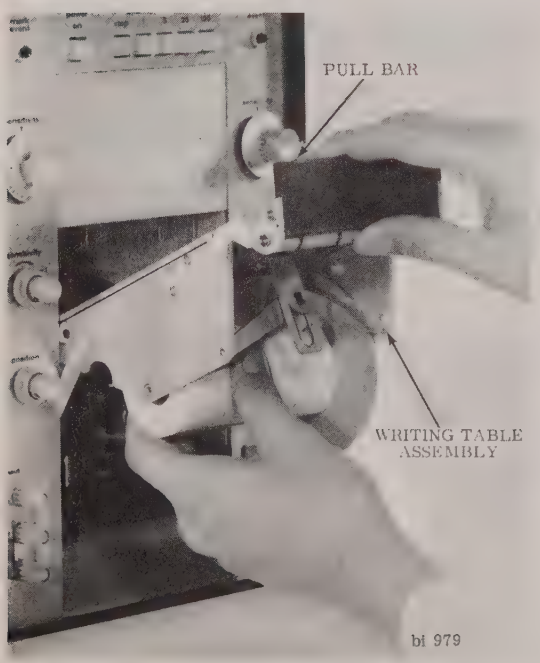


FIGURE 4-1 CHANGING CHART PAPER (1 of 4)

4. Hold paper supply core and shaft and pull down on paper supply release lever (Fig. 4-2) and remove paper supply core and shaft.
5. Unscrew paper core from supply roll shaft and discard paper core.

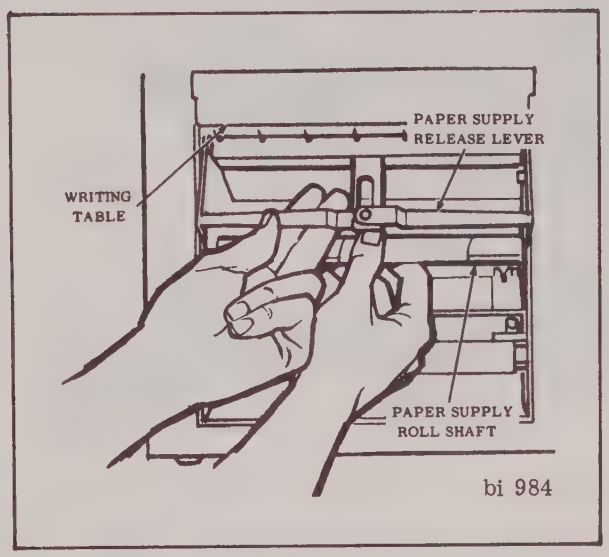


FIGURE 4-2 CHANGING CHART PAPER (2 of 4)

b. Installation

1. Slide new roll of paper onto supply roll shaft.

NOTE: Check to be sure flange of shaft is at right side adjacent to channel 2 on chart paper and paper unwinds from top of roll.

2. Screw supply roll shaft into paper core so that flange is snug against paper core.
3. Insert flanged end of paper supply roll shaft into shaft mounting holes in writing table assembly (Fig. 4-3), and push up on release lever to lock shaft into position.

CAUTION: CHECK TO BE SURE LEFT END OF SUPPLY ROLL SHAFT IS SEATED IN WRITING TABLE ASSEMBLY AND SUPPLY ROLL SHAFT ROTATES FREELY.

4. Feed paper over writing bar, through slot in front of writing table, behind pressure roll and out front of writing table assembly (Fig. 4-4).

NOTE: Refer to paper threading diagram on side of writing table assembly.

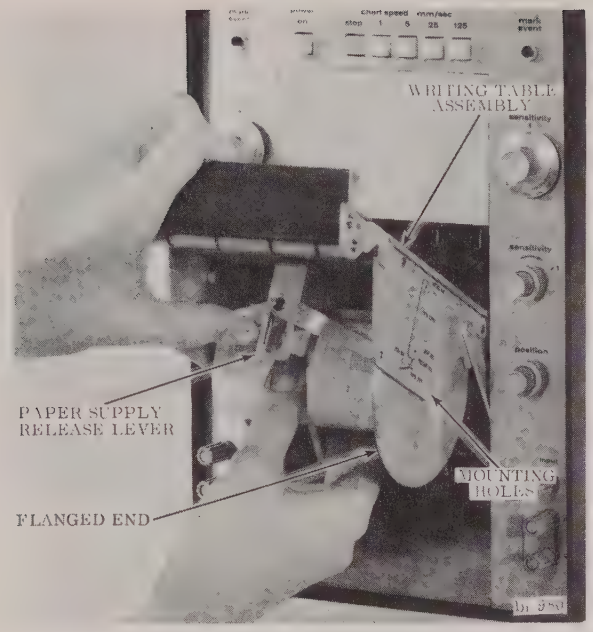


FIGURE 4-3 CHANGING CHART PAPER (3 of 4)

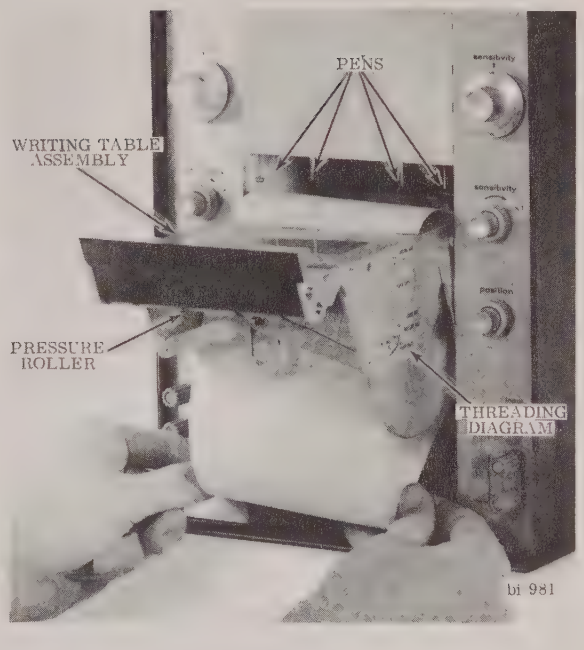


FIGURE 4-4 CHANGING CHART PAPER (4 of 4)

CAUTION: USE CARE DURING PAPER THREADING NOT TO DAMAGE PENS.

5. Slowly close writing table assembly while gently pulling on paper. When friction resists rotation of paper roll, pull paper taut, center on writing table, and close writing table.

NOTE: Check to be sure writing table is properly engaged by pressing on both sides of writing table.

6. Turn recorder on and operate at 125 millimeters per second to run about two feet of chart paper to align chart paper.

4.3 COVER ASSEMBLY

The cover assembly must be removed to perform certain maintenance and calibration procedures on the recorder.

WARNING: CHECK TO BE SURE RECORDER IS TURNED OFF AND DISCONNECTED FROM A-C POWER SOURCE.

a. Removal

1. Lay recorder on rear panel and remove four screws attaching rubber feet and cover assembly to bottom of recorder.

2. Return recorder to upright position.

3. Carefully slide recorder forward out of cover assembly.

b. Installation

1. Carefully slide recorder into front of cover assembly.

CAUTION: CHECK TO BE SURE WIRES ARE NOT PINCHED BETWEEN COVER AND RECORDER CHASSIS.

2. Lay recorder on rear panel and install four screws attaching rubber feet and cover to recorder.

3. Return recorder to upright position.

4.4 REPLACING ANALOG PEN

This paragraph describes and illustrates the procedures for removing and installing the analog pens.

a. Removal

1. Remove pen access cover (located above writing table) by pulling out on bottom of access cover.

2. Use a screwdriver and rotate individual ink valve button to OFF position (Fig. 4-5).

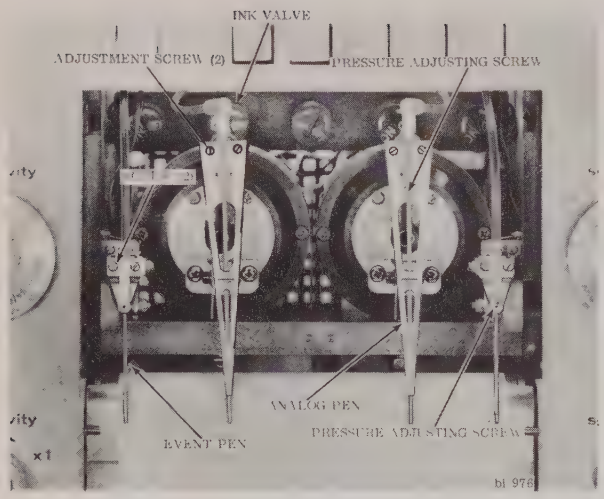


FIGURE 4-5 REPLACING ANALOG PEN (1 of 2)

3. Gently remove pen ink tube from manifold nipple.

NOTE: Place a tissue under nipple and ink tube to prevent ink dripping on recorder components.

4. Use pen replacement wrench (part number 1-120922-2) and loosen set screw through access hole on side of penmotor drive arm shaft (Fig. 4-6) and remove wrench.

5. Remove pen from penmotor drive arm shaft.

NOTE: Do not loosen set screw more than one-half turn or pen cannot be removed from shaft.

b. Installation

1. Carefully slide replacement pen onto penmotor drive arm shaft.

2. Align set screw in pen hub with access hole in drive arm shaft and "snug up" set screw using pen replacement wrench. Remove wrench.

NOTE: Set screw should be tightened to create friction, but loose enough to allow pen to be rotated in penmotor hub.

3. Install proper pen tube (3.34" long with right angle bend) between manifold and pen.

CAUTION: DO NOT USE SHARP INSTRUMENT.

4. Use screwdriver and turn individual ink valve button to ON position.

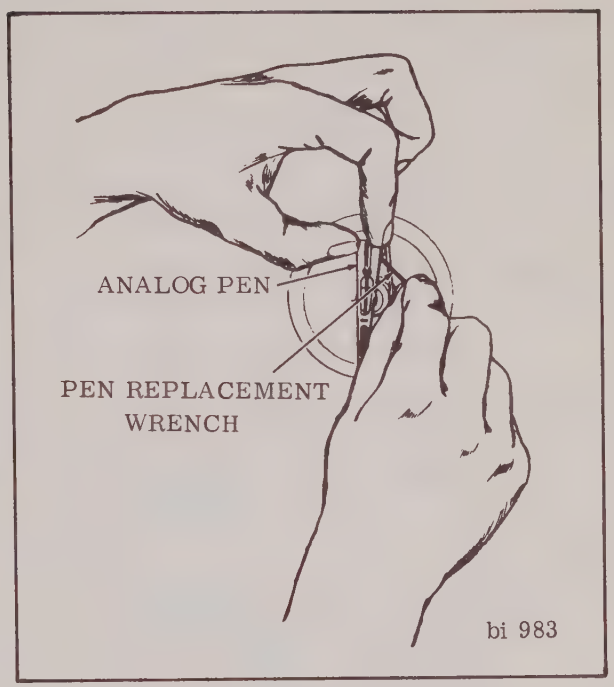


FIGURE 4-6 REPLACING ANALOG PEN (2 of 2)

5. Connect recorder to proper a-c power source and turn on recorder power.

6. Use pen POSITION control, and place pen at chart center.

7. Operate recorder at five millimeters per second.

8. Lift pen slightly to allow ink to bleed through pen tip.

9. Press recorder chart speed STOP button and turn power off.

10. Gently grasp pen near hub and move pen across entire chart width (40mm).

11. If ink trace is not parallel to a horizontal time line, gently turn pen in penmotor drive arm until trace is parallel to time line.

12. Use pen replacement wrench, tighten set screw securing pen in penmotor drive arm shaft and remove wrench.

13. If pen tip is not on same time line as other pens, loosen two pan head adjustment screws (Fig. 4-5) and slide pen up or down until all pen tips are on same time line, and tighten screws.

14. Check pen pressure and adjust if required (Para. 4.8).

NOTE: The following steps pertain to Pen, Model 11-2823-33 only. For instructions on Extended Life Pen, Model 11-2823-34, refer to Para. 4.12.

15. New pen must be lapped before proceeding. Carefully raise pen tip just enough to slide a small strip of emery paper (3M wet or dry Tri-m-ite paper, Grit M-600, Brush part number 669234) under pen tip.

16. Move emery paper back and forth five or six times, parallel to chart time lines.

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

17. Remove emery paper, operate recorder at 5MM/SEC and check pen for dryness.

18. If writing is not dry, proceed with normal pen lapping as described in Para. 4.9.

19. Install pen access cover.

4.5 REPLACING EVENT PEN MODEL 11-2873-20

This paragraph describes and illustrates removal and installation of the event marker pen.

a. Removal

1. Remove pen access cover (located above writing table) by pulling out on bottom of access cover.

2. Use a screwdriver and rotate event marker individual ink valve button to OFF position.

3. Gently remove pen ink tube from manifold nipple (do NOT use sharp instrument).

NOTE: Place a tissue under nipple and ink tube to prevent ink dripping on recorder components.

4. Loosen two screws attaching pen to event marker and remove pen from event market (Fig. 4-5).

b. Installation

1. Slide replacement pen onto event marker and align pen tip on vertical grid line and on same time line as analog pen.

2. Tighten two screws attaching pen to event marker (Fig. 4-6).

3. Install proper pen tube (5.6" long) between manifold and pen.

4. Use screwdriver and rotate event marker ink valve button to ON position.

5. Connect recorder to proper a-c power source and turn on recorder power.

6. Operate recorder at 5 MM/SEC.

7. Lift pen slightly to allow ink to feed through pen tip.

8. Check pen pressure and adjust if required (Para. 4.8).

9. New pen must be lapped before proceeding. Carefully raise pen tip just enough to slide a small strip of emery paper (3M wet or dry Tri-m-ite paper, Grit M-600, Brush part number 669234), under pen tip.

10. Move emery paper up and down five or six times, parallel to division lines.

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

11. Remove emery paper, operate recorder at 5MM/SEC and check pen for dryness.

12. If writing is not dry, proceed with normal pen lapping as described in Para. 4.9.

13. Install pen access cover.

4.6 REPLACING PENMOTOR BAND ASM ON PENMOTOR 881993 (Fig. 4.9)

The penmotor band assembly (part number 680294) should not be removed unless broken. Because band tension is critical, a band replacement tool (part number 341409-915) must be used to replace band assembly.

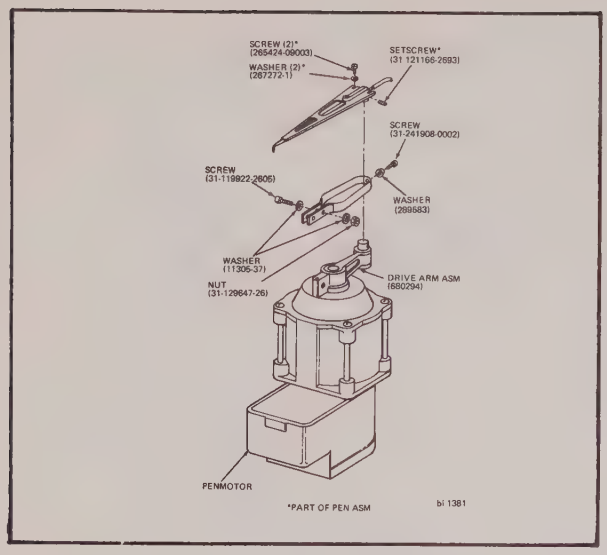


FIGURE 4-7 PENMOTOR ASSEMBLY

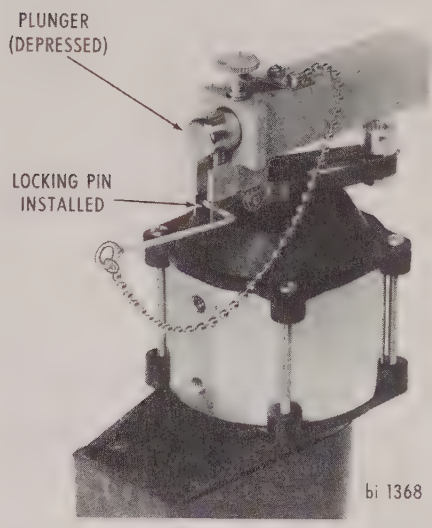


FIGURE 4-8 BAND TOOL MOUNTING

NOTE: Penmotor need not be removed from recorder.

1. Remove analog pen (Para. 4.4).
2. Remove socket-head cap screw and band clamping (curved) washer that secures band assembly to drive arm (use wrench 1-120922-3).
3. Remove socket-head cap screw, hex nut and two flat washers that secure band assembly to penmotor (use wrench 245218-5). Discard damaged band assembly.

CAUTION: TO PREVENT DAMAGE TO THE NEW BAND ASSEMBLY, CHECK TO BE SURE DRIVE ARM AND BRACKET ARE FREE OF NICKS, DIRT, INK BEFORE INSTALLING NEW BAND ASSEMBLY.

4. Position new band assembly around drive arm hub. Align mounting holes with tapped holes in drive arm bracket and install two screws and lock washers. Do not tighten screws.

NOTE: Check to be sure curved portion of washer is positioned to conform the radius of the drive arm hub. Use care not to nick or scratch band assembly.

5. Carefully install band clamping washer and socket-head screw.
6. Inspect band for proper positioning around drive arm hub so that equal pressure is maintained on top and bottom of band assembly.
7. Install band tool of penmotor and thread knurled thumb screw into penmotor (Fig. 4-8).
8. Depress plunger and insert locking pin into two small holes of band assembly, making certain plunger is behind locking pin.
9. Tighten screw in penmotor, loosen one-quarter turn, move drive arm back and forth several times to center band assembly and tighten screw.
10. Move drive arm back and forth several times to center band assembly on drive arm and tighten socket-head screw securing band assembly to drive arm.

NOTE: Do not tighten more than 22 inch-ounces.

11. Depress plunger and remove locking pin.
12. Loosen knurled screw securing band tool to drive arm bracket and remove tool.
13. Apply glyptal cement (or equivalent) to heads of the two screws and to nut to prevent loosening.
14. Install analog pen (Para. 4.4).

4.7 PEN PRESSURE MEASUREMENT

Analog or event marker pen pressure should be checked if the ink trace is excessively wide

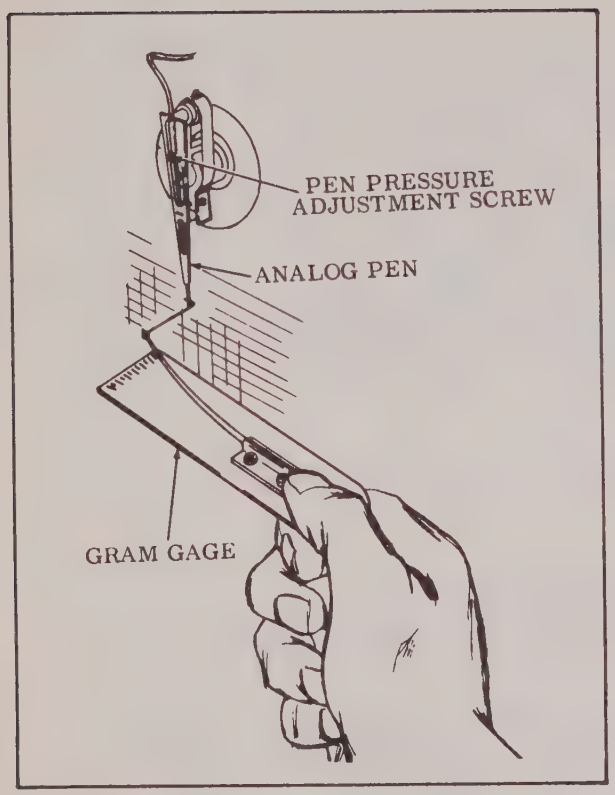


FIGURE 4-9 PEN PRESSURE MEASUREMENT

(bleeding), indicating low pen pressure or if pen gouges the chart paper, indicating excessive pen pressure.

NOTE: Wide trace may also indicate an improperly lapped pen. Refer to Paragraph 4.8 for pen lapping procedures.

The gram gage (part number 240601-910) is used to measure the pressure of the analog and event marker pens as follows:

1. Turn SENSITIVITY control to OFF position.
2. Depress POWER ON button to turn on recorder.
3. Remove pen access cover (located above writing table) by pulling out the bottom of access cover.
4. Press the 1MM/SEC chart speed button.
5. Place gram gage hook under pen shaft as close as possible to tip and form a right angle to pen shaft with gage hook (Fig. 4-9).
6. Pull pen from chart and take reading on gage the moment excessive ink starts to flow from pen.
7. Proper writing pressure for analog pens is 28 to 32 grams. Event marker pen pressure is 20 to 25 grams.

FIGURE 4-10 PEN PRESSURE ADJUSTMENT

When pens are replaced, pen pressure must be checked and if required, adjusted as follows:

8. Use pen pressure adjustment wrench (part number 1-120922-18) and turn adjusting screw (Figs. 4-4 and 4-10) clockwise to increase pressure or counterclockwise to decrease pressure.
9. Check pen pressure with gram gage and continue adjustment until proper reading is obtained.
10. Install pen access cover. Recorder is ready for operation.

4.8 PEN LAPPING

NOTE: Extended Life Pen, Model 11-2923-34, must be lapped as described in Para. 4.11.

a. General

This paragraph describes and illustrates the proper procedures for lapping the analog and event pens. Intermittent or "wet" ink trace are indications that pen pressure is incorrect or that pen requires lapping. Check for "wet" writing by operating the recorder at 5 MM/SEC chart speed, with the SENSITIVITY control in OFF position. Check pen trace by wiping index finger, with moderate pressure, across trace approximately one inch below pen tip. If ink does not smear, the pen is properly lapped. If trace smears, check and adjust pen pressure (Para. 4.7). Repeat test, and if trace continues to smear, lapping is required.

b. Lapping Procedure

NOTE: Lapping of pens should only be done when required.

1. Turn recorder off.

2. Remove pen access cover (located directly below chart speed selector switch) by pulling on bottom of access cover.

3. Carefully raise pen tip just enough to slide a small strip of emery paper (4/0, Brush part number 141119) under pen tip.

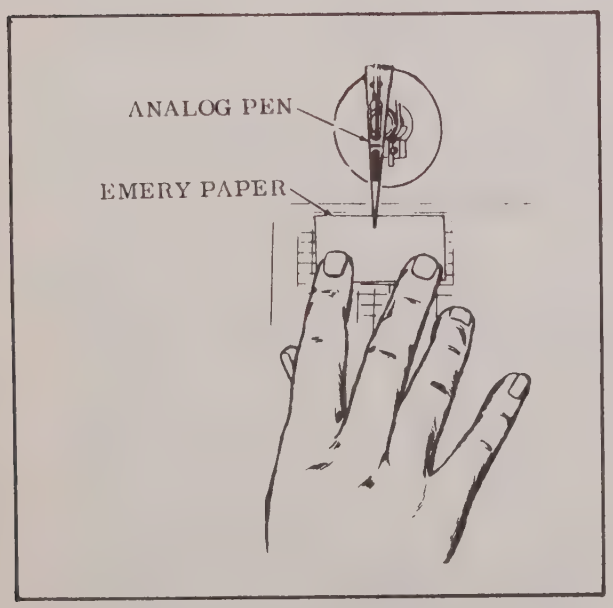


FIGURE 4-11 PEN LAPPING

CAUTION: DO NOT USE A COARSE OR VERY ABRASIVE TYPE OF EMERY PAPER. USE ONLY THE GRADE SPECIFIED.

4. Move emery paper back and forth under pen tip, parallel to chart time lines, for a total distance of approximately two inches. (Fig. 4-11).

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

5. Remove emery paper, operate recorder at 5 MM/SEC and check pen trace for dryness.

6. Repeat steps 3 thru 5 as required to obtain dry trace.

NOTE: If procedure is repeated more than three times, recheck pen pressure and repeat lapping. Strict adherence to above lapping procedures is imperative.

7. When dry trace is achieved, replace access cover.

4.9 INK CARTRIDGE REPLACEMENT

This paragraph describes and illustrates the procedures for replacing the Ink Cartridge, Model 11-2730-01.

a. Removal

1. Remove recorder cover assembly (Para. 4.3).

2. Remove four screws and lock washers (two screws and lock washers located inside rubber mounts) attaching rear panel to recorder and carefully move rear panel free and clear of work area.

CAUTION: POWER CABLE, FUSE LEAD, AND EVENT MARKER LEADS WILL REMAIN ATTACHED TO REAR PANEL. EXERCISE CARE WHEN MOVING PANEL SO THAT LEADS ARE NOT BROKEN.

3. Turn activating screw (Fig. 4-12) clockwise until compression spring in ink plunger has been drawn up tight into ink plunger assembly and ink flow stopped.

CAUTION: PLACE PAPER TOWELS OR TISSUES UNDER INK SYSTEM TO PREVENT INK DRIPPING ON RECORDER COMPONENTS.

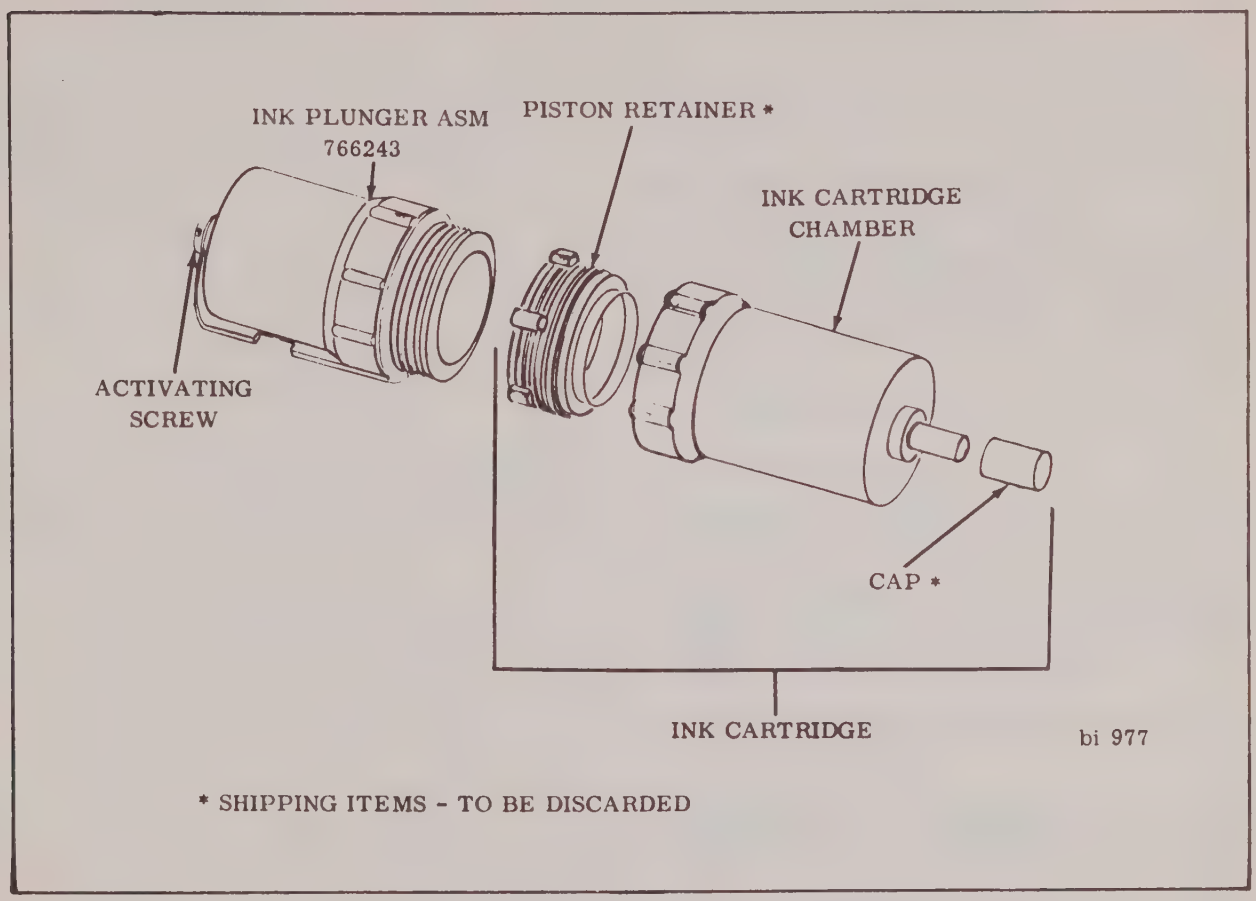


FIGURE 4-12 INK CARTRIDGE, MODEL 11-2730-01

4. Carefully remove ink tube adapter assembly from ink cartridge.

5. Unscrew ink cartridge chamber from plunger assembly and discard cartridge.

b. Installation

1. Remove plastic piston retainer ring from replacement cartridge and discard retainer (Fig. 4-12).

2. Install ink cartridge in plunger assembly and tighten securely.

3. Remove shipping cap from ink cartridge and discard shipping cap.

4. Install ink tube adapter assembly on cartridge.

NOTE: Do not use tweezers or other sharp instruments to install adapter.

5. Turn activating screw (Fig. 4-12) counterclockwise until snug to pressurize ink system.

6. Install recorder rear panel using four screws and lock washers and two rubber feet.

7. Connect recorder a-c power cable to proper power source.

8. Turn recorder on and operate recorder at a chart speed of 5 MM/SEC.

9. Gently raise each pen tip away from paper and allow ink tube to fill with ink and bleed air from tube until no air bubbles are formed at pen tip.

10. Press recorder STOP button and disconnect a-c power cord from source.

11. Install recorder cover assembly (Para. 4.3).

4.10 PEN CLEANING

In the event that a pen should fail to write or displays intermittent writing, it may be caused by a clogged pen. The procedure outlined below is intended as a guide to flush pens, but may not always prove effective.

1. Turn recorder off.
2. Close ink valve on affected channel.
3. Remove ink tubing from manifold.
4. Remove pen (Para. 4.4a or 4.5a).

NOTE: Do not remove tubing from pen unless tubing is kinked or suspected of being defective. Use Brush part number 667277 for analog pen tubing and part number 666587 for event pen tubing.

5. Modify hypodermic needle per Fig. 4-13

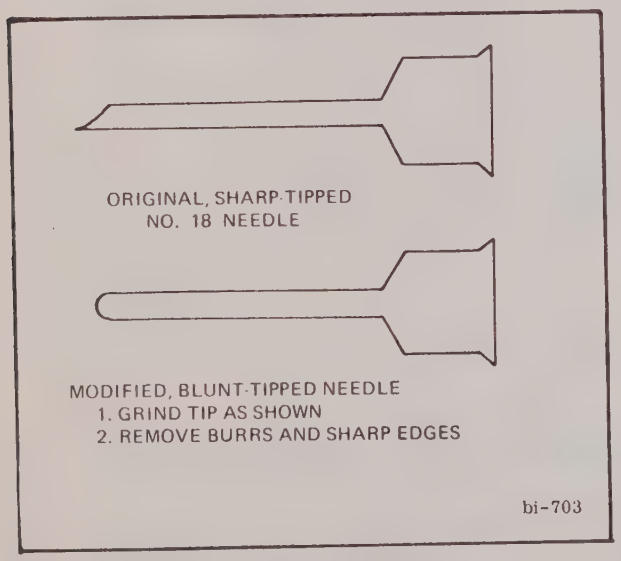


FIGURE 4-13 HYPODERMIC NEEDLE

6. Attach modified needle onto 2cc hypodermic syringe.
7. Insert needle in pen tubing.
8. Immerse pen tip in cleaning agent. (Isopropyl Alcohol, Cell-O-Solve or equivalent).
9. Back-flush by slowly withdrawing syringe plunger.

NOTE: It may be necessary to allow the pen to remain in the cleaning agent to dissolve dried ink at pen tip.

10. Install pen (Para. 4.4b or 4.5b).

NOTE: Clogging of pens may occur when proper adjustment, operating and/or handling as per Gould Operating Manual has not been adhered to.

4.11 LAPPING PROCEDURES FOR EXTENDED LIFE PEN, MODEL 11-2823-34

The Brush Model 11-2823-34 Extended Life Pen requires a different lapping procedure from that described in Para. 4.8. Install pen as described in Para. 4.3, but disregard lapping instructions referred to.

Lap Extended Life Pen as follows:

1. Remove pen access cover.
2. Shut off ink manifold knobs of all channels by rotating all knobs counterclockwise.
3. Raise writing table and rewind chart paper so that no paper is left under pen tips. Be sure sufficient paper is on roll to energize interlock switch to permit recorder operation.
4. Close table and set pen pressure to 30 grams against writing bar.
5. Place coarser of two lapping papers supplied (Brush part number 668963) under pen tip and drive pen at 60 Hz, 1/2 of full scale.
6. Simultaneously move lapping paper back and forth under pen. Lap in this manner for 90 seconds.
7. Now repeat procedure using finer lapping paper (Brush part number 668965) for 90 seconds.
8. Return recorder to normal operating condition (thread chart paper over writing bar and turn ink control knobs on).

NOTE: In most cases, one lapping will suffice, but occasionally two or three will be required to effect a proper seal.

9. If pen tip should become blocked during lapping operation, touch pen at top of bend (above tip) with a hot soldering iron for a few seconds with pen tip slightly raised off paper. This will generally start ink flowing and flush out abrasive.
10. Install pen access cover.

SECTION V

CALIBRATION

5.1 GENERAL

The Brush 220 Recorder has been factory calibrated, and under normal conditions will not require calibration. However, because of parts replacement or repair, calibration may be necessary. This section describes and illustrates the correct calibration procedures. It should be pointed out that calibration should only be performed by qualified personnel familiar with procedures and standards.

5.2 TEST EQUIPMENT REQUIRED

The following is a list of recommended test equipment necessary for calibration.

NOTE: Specific manufacturer need not be adhered to, but comparable equipment is mandatory, since accuracy stated is imperative.

a. Function Generator (Hewlett-Packard, Model 202A, or equivalent).

b. D.C. Power Supply, 0 to 5 volts ±0.1% (floating).

NOTE: A precision voltmeter (Fluke 883A or equivalent) may be used to monitor D.C. Power Supply to insure accuracy if precision D.C. Power Supply is not available.

5.3 PROCEDURE

NOTE: Procedure outlined is typical of both channels.

1. Remove unit from case (Para. 4.3) or slide unit forward out of rack to expose calibration controls (Fig. 5-1).

2. Connect unit to proper power source as indicated on unit nameplate.

3. Depress POWER ON on pushbutton and allow a fifteen minute warm-up time.

4. Set pen to exact chart center with pen POSITION control.

5. Depress 5 MM/SEC chart speed button. Disconnect drive amplifier input by carefully removing white/black/brown wire from quick disconnect point 1.

6. Connect one end of test clip lead to drive amplifier input 1 .

7. Alternately open and short input to ground (chassis).

8. Adjust ICO BAL (Balance) control for minimum pen movement when opening and shorting to ground.

9. Connect clip lead from drive amplifier input terminal 1 to recorder ground (chassis).

10. Center pen by adjusting ZERO control located on amplifier board.

11. Disconnect clip lead from amplifier input to ground, and connect white/black/brown wire from preamplifier.

12. Turn SENSITIVITY control to OFF position.

13. Continue to operate recorder at chart speed of five millimeters per second.

14. Verify that pen is at exact chart center; if not, use PEN POSITION control and set pen at exact chart center.

15. Rotate variable SENSITIVITY X1 control throughout its entire range several times and check for any pen deflection.

16. If no pen deflection is observed, preamplifier is properly balanced.

17. If observed pen deflection is greater than 1/4 division, adjust preamplifier BALANCE control for no pen deflection while rotating SENSITIVITY X1 control throughout its entire range.

18. Set SENSITIVITY control to 100 mv/div position.

19. Apply ±2.5 V d-c ±0.1% to input terminals. Adjust SPAN control for exactly 25 divisions of pen deflection.

20. Apply a 1 Hz squarewave of 25 divisions peak-to-peak amplitude. Adjust DAMPING control for best wave-form reproduction.

21. Check frequency response by apply a 10 Hz sine wave 10 divisions peak-to-peak. Increase frequency to 100 Hz; amplitude response must remain flat (±1 division). Increase frequency to 125 Hz; amplitude

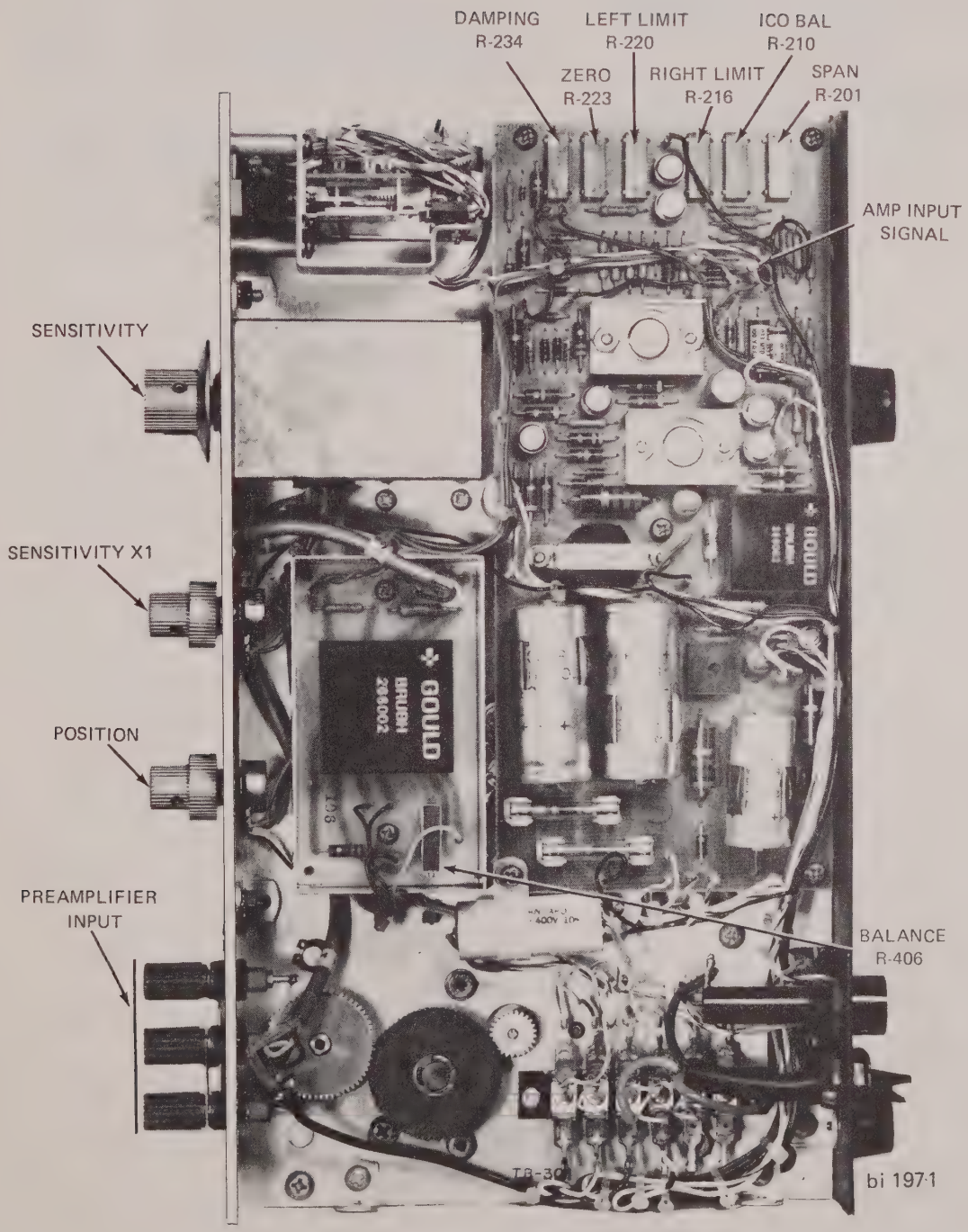


FIGURE 5-1 CALIBRATION CONTROLS, DRIVE AMPLIFIER 869223

should be 7 divisions. Adjust DAMPING control if necessary.

22. Apply a 4 Hz sine wave, 50 divisions peak-to-peak. Increase frequency to 40 Hz. Amplitude should remain flat at 50 divisions, ± 1 division.

23. Apply positive 3 volts d-c to input and adjust LEFT LIMIT control to bring pen 1-1/2 to 2 divisions beyond chart edge.

24. Apply negative 3 volts d-c to input and adjust RIGHT LIMIT control to bring pen 1-1/2 to 2 divisions beyond chart edge.

This completes until calibration. Depress chart STOP button and disconnect all test equipment. Replace unit in case (Para. 4.3) or slide unit into rack, Unit is ready for operation.

SECTION VI

THEORY OF OPERATION

6.1 GENERAL

The Brush 220 Recorder consists of two analog channels, associated preamplifiers, penmotor drive amplifiers and power supplies (Fig. 6-1). The input signal to each channel is differential balanced-to-ground or single-ended by use of ground strap. Attenuation of input signal is accomplished by controls on the front panel.

Penmotor drive amplifier is a complete servo-type system utilizing a Metrisite transducer in the penmotor to develop position and a tachometer generator to derive velocity.

6.2 DETAILED DESCRIPTION, DRIVE AMPLIFIER NETWORK ASM 869223

a. Regulated D.C. Power Supply Circuit (Figure 6-2)

Primary power to each channel is applied to transformer T-301, and rectified by full wave rectifier bridge, CR-215. The common output point of transformer T-301 is tied to ground. The output voltages, plus and minus 32 volts d-c are applied to the output stages of the drive amplifier. Regulated plus and minus 18 volts d-c to preamplifier and to amplification stages of drive amplifier are derived from resistors R-230 and R-231, and zener diodes CR-209 and CR-210. Regulated minus 5.6 volts, derived from resistor, R-245, and zener diode, CR-208 and regulated plus 5.6 volts, an output of oscillator A-201, are applied to the pen POSITION control, R-302.

b. Drive Amplifier and A.C. Feedback Circuit (Figure 6-2)

The drive amplifier acts as an error amplifier in that the input signal is constantly compared with pen position and assures that pen position on the chart accurately displays the input signal.

The summing of the amplifier is at the input of amplifier IC-201. The input signal is summed thru

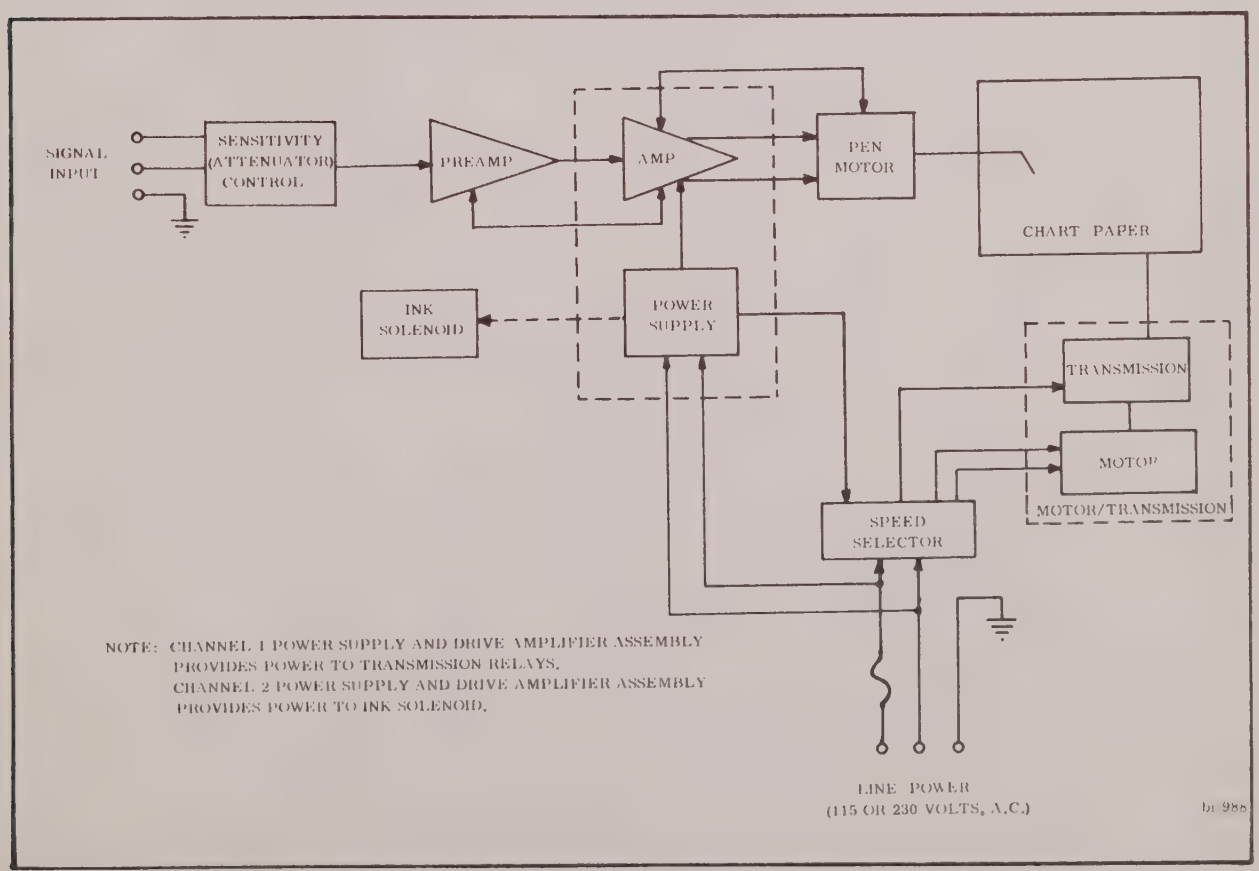


FIGURE 6-1 BRUSH 220 RECORDER – FUNCTIONAL BLOCK DIAGRAM

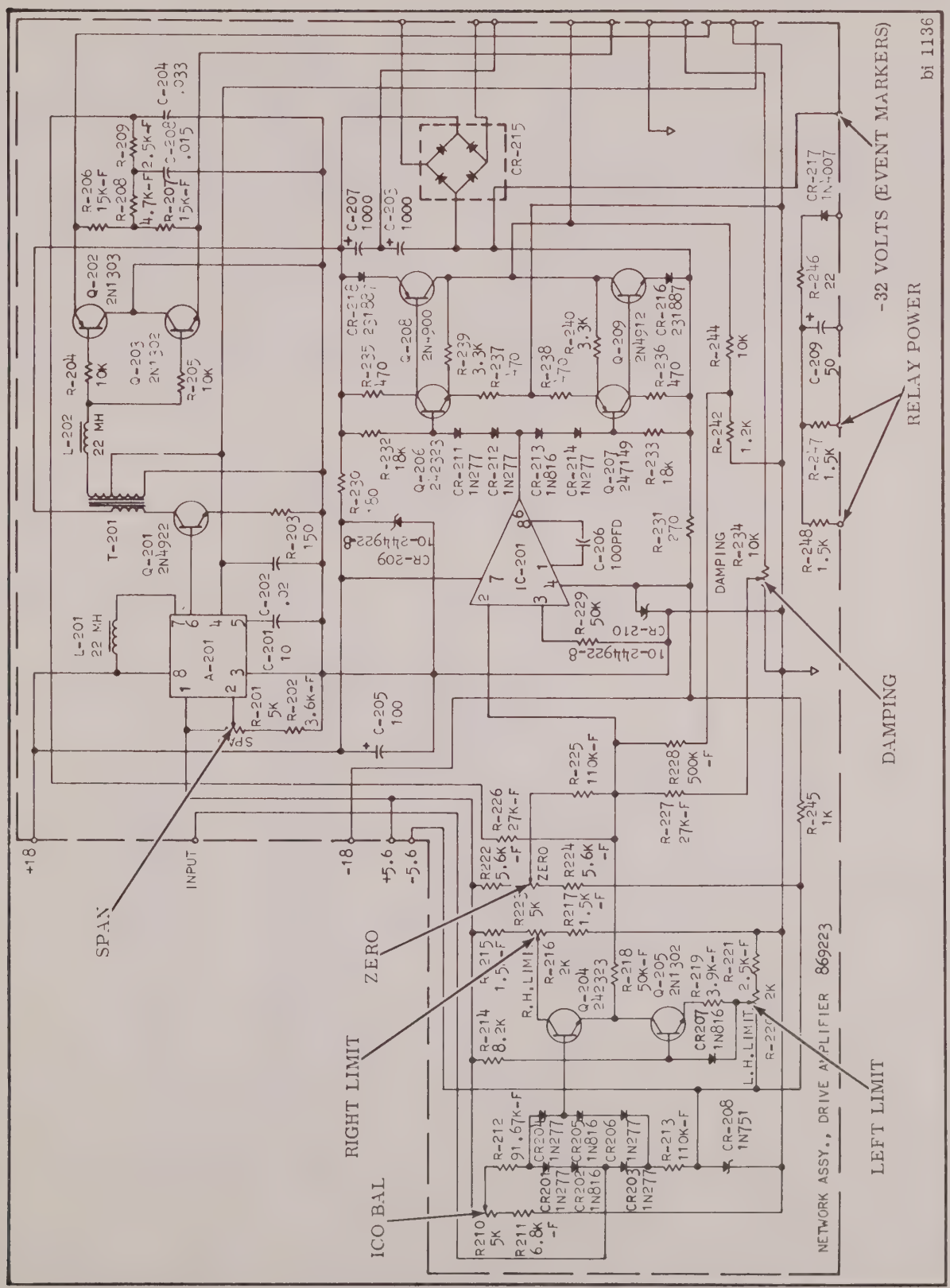


FIGURE 6-2 AMPLIFIER AND POWER SUPPLIES NETWORK ASM 869223

resistor, R-218. The demodulated signal from the position sensing transducer (Metrisite) is summed thru resistor R-226. Resistor, R-225, serves as a summing resistor for the zero adjustment current thru ZERO control, R-223. Resistor, R-228, serves as the open-loop feedback path for the amplifier. Resistor , R-227, sums the velocity feedback signal which is derived from a tachometer generator within the penmotor. DAMPING control, R-234, permits adjustment for optimum frequency response and waveform reproduction.

Any error voltage is amplified by amplifier, IC-201, transistors, Q-206 and Q-207, which form a phase-splitting driver stage for the output transistors, Q-208 and Q-209.

c. Left and Right Limiter Circuit (Figure 6-2)

The output of the preamplifier is applied to the base of an emitter-follower transistor, Q-204, through diode network CR-201, CR-202, CR-203, CR-204, CR-205 and CR-206. The diode network provides the necessary bias and temperature compensation to assure a stable output from the limiters. Transistor Q-205 functions as a current source and emitter load for transistor Q-204. RIGHT LIMIT adjust, R-216, and LEFT LIMIT adjust, R-220, limit the voltage swing of transistor Q-204 which instantaneously clips any excess voltage applied to the limiters.

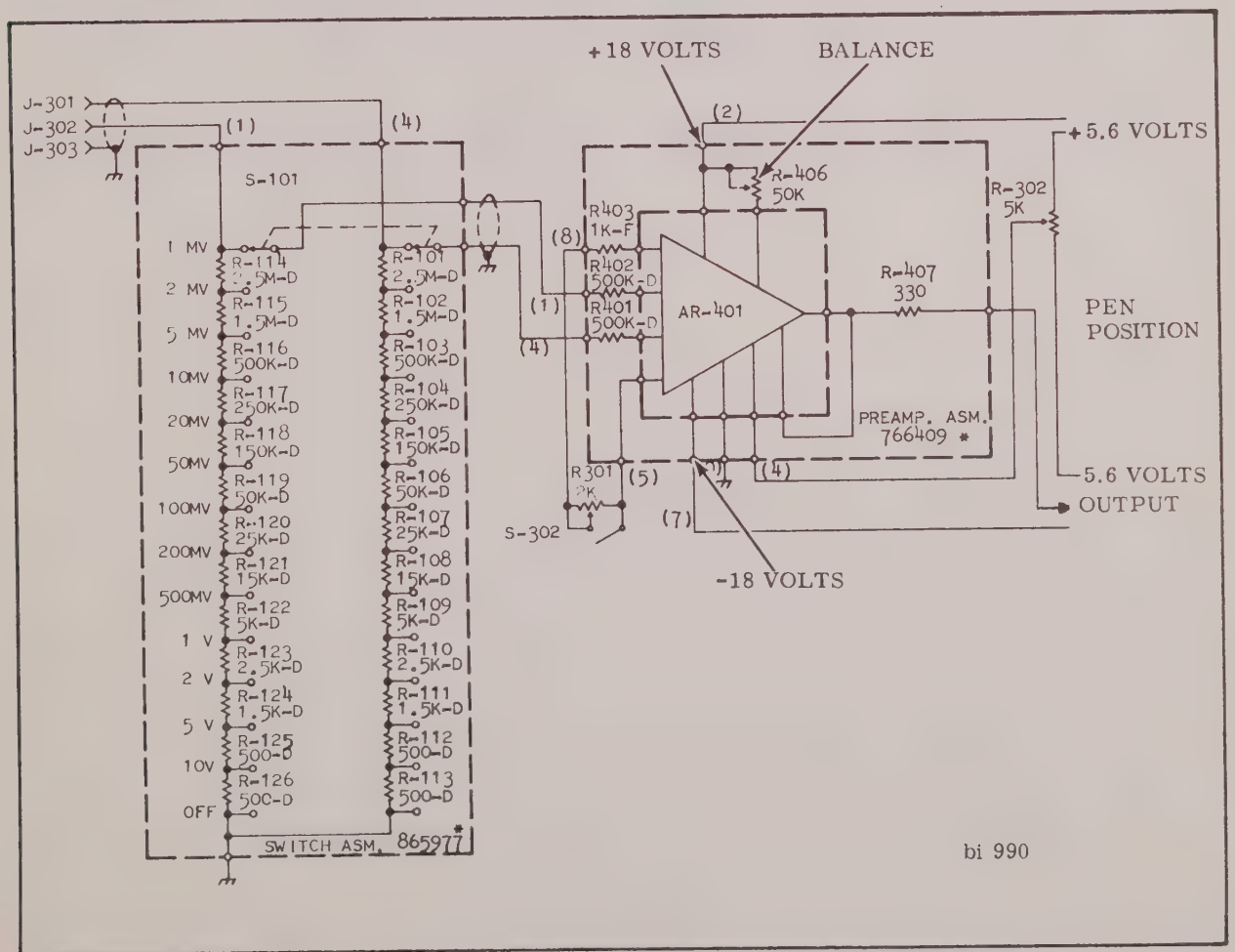


FIGURE 6-3 PREAMPLIFIER AND SENSITIVITY SWITCH CIRCUITS

d. 20 KHz Oscillator and Demodulator Circuits

Oscillator, A-201, contains the 20 KHz circuit. Amplitude adjustment is provided by applying a variable d-c voltage from variable resistor, R-201, to terminal 2 of the module. An additional terminal (pin 4) is provided to allow additional components to be added to oscillator control loop.

The oscillator output voltage is amplified by transistor, Q-201 and further stepped up by transformer, T-201, which has a tapped secondary winding providing two outputs. One output (tap) is applied to primary of position-sensing transducer (Metrisite). This same output is applied to Oscillator, Q-201, to correct for any change in output amplitude from transformer, T-201.

The second output voltage of transformer, T-201 is applied thru reactor, L-202, (phase-shifting coil) to the phase-sensitive demodulator consisting of transistors, Q-202 and Q-203, and resistors R-204 and R-205.

The varying output voltage from the Metrisite is then applied to the demodulator circuit across resistors, R-202 and R-207. The demodulated and filtered output of the Metrisite circuit is then applied to the error amplifier thru resistor, R-226.

6.3 SENSITIVITY (ATTENUATOR) CONTROL AND PREAMPLIFIER CIRCUITS (FIGURE 6-3)

Input signals are applied to the balanced attenuator network consisting of resistors R-101 thru R-126. The differential input signal from the attenuator network is applied to the input of the preamplifier module, AR-401, thru protective resistors, R-401 and R-402.

With the variable SENSITIVITY control (R-301/S-302) in the detent (X1) position, the preamplifier assembly operates at a gain of 100 which is set by resistor, R-403. The variable SENSITIVITY control places a portion of resistor, R-301 in series with resistor, R-403, and varies the gain down to 40. The single-ended output of the preamplifier assembly is applied to the drive amplifier thru the limiter circuit.

Pen position voltage, from the wiper arm of POSITION control, R-302, is applied to a reference terminal of preamplifier module, AR-401.

SECTION VII

TROUBLESHOOTING

7.1 GENERAL

This section contains troubleshooting hints to assist operating or maintenance personnel in isolating malfunctions that may occur during normal operation of the Brush 220 Recorder. All malfunctions are listed in sequence. Be sure to check all steps in sequence to isolate a malfunction.

7.2 ELECTRICAL POWER MALFUNCTIONS

MALFUNCTION	CAUSE	REMEDY
1. Recorder inoperative (lamp will not turn on) with power switch depressed	a. Unit not connected to power source	a. Connect unit
	b. Main fuse blown	b. Replace fuse after correcting malfunction (Fig.8-1, item 31)
	c. Chart paper interlock switch open	c. Load chart paper (Para.4.2; adjust or replace switch (Fig. 8-2, item 10)
	d. Power switch not making contact	d. Repair or replace switch (Fig. 8-1,item 10)

7.3 CHART DRIVE MALFUNCTIONS

1. Unit chart will not drive with any chart speed button depressed	a. Idler (fiber) gear excessively worn	a. Replace idler gear (Fig. 8-1, item 47)
	b. Motor defective	b. Replace motor or motor/ transmission (Fig.8-1,item 54)
	c. Chart speed switch defective (not supplying voltage to drive motor)	c. Replace chart speed switch (Fig.8-1, item 10)
2. Chart runs at only one, two, or three speeds	a. Channel 1 drive amplifier relay power supply defective	a. Repair or replace (Fig.8-1, item 41)
	b. Transmission relays, resistors, defective	b. Replace relays or resistors (Fig. 8-1, item 54)
	c. Chart speed switch defective	c. Repair or replace switch (Fig. 8-1, item 10)
3. Chart speed consistently not accurate	a. Drive roll worn excessively	a. Clean or replace
4. Chart speeds erratic	a. Idler (fiber) gear worn	a. Replace idler (fiber) gear (Fig. 8-1, item 47)
	b. Transmission clutch springs defective	b. Replace transmission (Fig. 8-1, item 54)

7.4 PEN INKING MALFUNCTIONS		
MALFUNCTION	**CAUSE**	**REMEDY**
1. No trace or faint trace	a. Ink supply exhausted	a. Replace (Para. 4-9) (Fig. 8-1, item 13)
	b. Ink cartridge screw not full counterclockwise	b. Rotate screw to full counterclockwise position (Para. 4.9)
	c. Ink manifold OFF/ON knobs not in full ON position	c. Rotate to full ON position (Fig. 4-5)
	d. Ink manifold solenoid de-energized	d. Repair or replace channel 2 (Fig. 8-1, opposite item 41) drive amplifier relay power supply
	e. Pens clogged	e. Clean or replace (Para. 4.10, 4.4,4.5)(Fig.8-1,item68 & 70)
2. Ink trace heavy or wet; pen tears or gouges paper	a. Pen worn excessively	a. Replace pen (Para. 4.4,4.5) (Fig. 8-1, item 68 & 70)
	b. Pen not properly lapped	b. Lap pen (Para. 4.8)
	c. Pen pressure too heavy or too light	c. Set pen pressure (Para.4.7)
3. All pens not on same time line	a. One or more pens out of alignment	a. Set pen alignment (Para. 4.4,4.5)
4. Pen does not return to same spot; sloppy	a. Pen loose	a. Align and tighten pen (Para. 4.4,4.5)
	b. Band loose or broken	b. Tighten or replace band (Para. 4.7)
7.5 SIGNAL MALFUNCTION		
1. Trace unusually wide	a. Noise appearing at pen tip.	a. Depress STOP button. If noise continues, repair or replace drive amplifier (Fig. 8-1, item 41). If noise ceases, release STOP button and turn SENSITIVITY control to OFF position. If noise continues, replace preamplifier (Fig. 8-1, item 44). If noise ceases, check signal source and signal input connections.

MALFUNCTION	CAUSE	REMEDY
2. No signal on either or both channels	a. Drive amplifier or preamplifier defective	a. Replace drive amplifier or pre-amplifier (Fig.8-1, item 41 & 44
	b. Drive amp fuse(s) blown	b. Replace fuse(s) after correcting malfunction (Fig. 8-7,F-201,F-202)
	c. Chart speed switch defective	c. Replace switch (Fig.8-1,item 10)
3. Pens limp or biased to either side	a. Drive amplifier or preamplifier defective	a. Repair or replace drive amplifier or preamplifier (Fig. 8-1, item 41 & 44)
	b. Recorder requires calibration	b. Calibrate recorder (Sec. V)
	c. Pen loose	c. Align and tighten pen (Para. 4.4,4.5)
	d. Band loose or broken	d. Tighten or replace band (Fig. 8-2, item 6)

SECTION VIII

PARTS IDENTIFICATION

8.1 GENERAL

This equipment has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the equipment.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the equipment. For replacement parts, refer to the appropriate Figures and their parts lists. The items listed present the lowest assembly or part but do not necessarily imply they are for sale. Contact your local branch for availability of salable components, assemblies or parts.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name and model number of the instrument.
2. Description of the part as listed in the manual.
3. Gould part number.

NOTE: Do not use the SYMBOL NUMBER from the parts lists for identifying desired parts on the order.

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
FIGURE 8-1

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	127457	Strap, Ground	
2	126395-13	Post, Binding	J-301, J-302, J-303
3	266558	Bracket	
4	2-128693-1	Grommet	
5	266494	Box, Metallic	
6	128327	Lamp	DS-301
7	266063	Lampholder	
8	869022	Manifold	
9	246552-1	Button	
10	264930	Switch, Pushbutton	S-301
11	232660-4	Clamp	
12	766243	Ink Plunger Asm	
13	11-2730-01	Ink Cartridge Asm	
14	269633	Bracket[1]	
15	269567	Switch[1]	
16	11-6101-21	Timer, 60 Hz[2] (see Fig. 8-5)	
17	269259	Switch, Pushbutton[1]	
18	866211	Cover Asm	
19	10-241145-224	Capacitor	C-301,C-302, C-101
20	265873-2	Jack, Banana	J-101,J-102,J-304, J-305,J-306,J-307
21	266107-5	Bail Asm (5 pc set)	
22	265814-6	Terminal Board	TB-302
23	265860	Bar, Support	
24	267280	Relay[3]	K-301
25	267362	Bracket[3]	
26	267377	Jack, Switch[3]	J-309
27	267423	Jack, 24-48 Volts[3]	J-308
28	465913-13	Plate, ID, Blank	
29		Part of Item 21	
30	109669	Holder, Fuse	

[1]Model 15-6327-57, 58 only
[2]Optional accessory equipment
[3]Model 15-6327-51 only

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW (Continued)
FIGURE 8-1

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
31	116198-29	Fuse (-50,51,55,57)	F-301
31	266924-9	Fuse (-56,58)	F-301
32	126295-7	Cable, Input	P-301
33	108572-11	Strain Relief	
34	240224	Switch [2,3]	S-101,S-307
35	267454	Cover	
36	667453	Insulator	
37		Same as Item 4	
38	865977	Switch Asm (Fig. 8-9)	S-101
39	246393-202	Resistor, Variable	R-301/S-302
40	246394-502	Resistor, Variable	R-302
41	869223	Network, Drive Amp (Fig. 8-7)	
42	124804-5	Clamp (60 Hz units)	
42	124804-7	Clamp (50 Hz units)	
43	10-261998-824	Capacitor (60 Hz units)	C-303
43	10-125905-105	Capacitor (50 Hz units)	C-303
44	766409	Network, Preamplifier (Fig. 8-8)	
45	666614	Shield Asm	
46	2-240731-11	Ring, Retaining	
47	243515	Gear, Spur, Idler	
48	232250-2	Bearing, Roller	
49	232660-3	Clamp	
50	265906-2	Gear, Spur (60 Hz units)	
50	265906-1	Gear, Spur (50 Hz units)	
51	266873	Post	
52	767269	Timer, 1/10 Second [3] (Fig. 8-10)	
53	265836	Gear, Spur	
54	865917	Transmission Asm 4 Speed (60 Hz)	
54	866706	Transmission Asm 4 Speed (50 Hz)	
54	881811	Transmission Asm 8 Speed (60 Hz)	
54	881990	Transmission Asm 8 Speed (50 Hz)	
	5-115558-182	Resistor [4]	R-501,R-502
	130198-1	Diode [4]	CR-501,CR-502
	232495	Relay [4]	K-501,K-502
	285921-2	Motor (60 Hz units) [4]	B-501
	286011	Motor (50 Hz units) [4]	B-501
	269945-7	Motor Belt	
	269945-6	Idler Belt (8-speed only)	
	269945-8	Transmission Belt	
55	466007	Case	
56	120903-214	Bumper	
57	11-6404-30	Cover[3] (see Fig. 8-5)	
58	266209-4	Handle	
59	266823	Lable, Channel ID	
60	285921-1	Fan[4] – Plastic	
	266412-1	Fan – Metal	

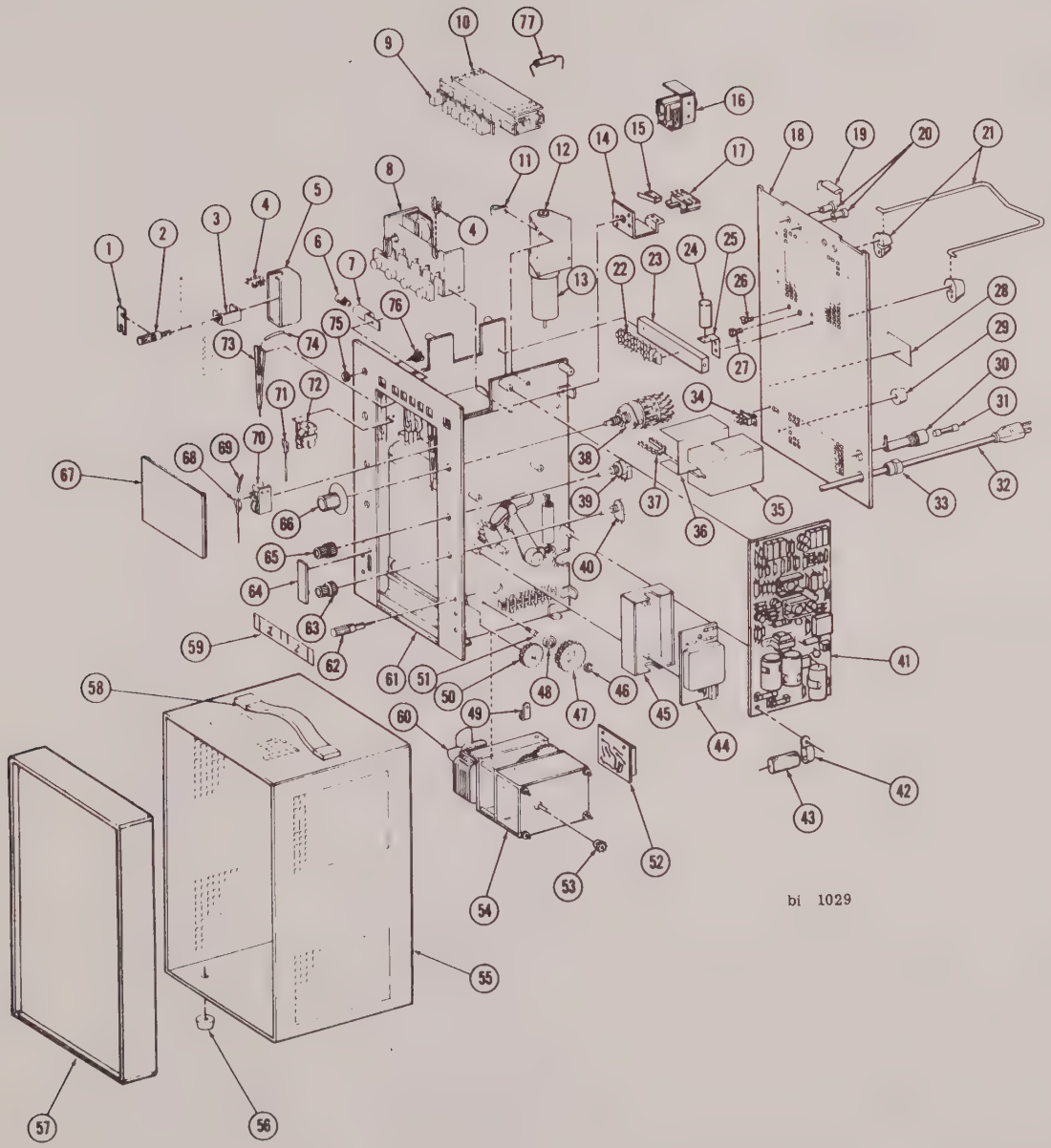
[1] Model 15-6327-57,58 only
[2] Optional accessory equipment
[3] Model 15-6327-51 only
[4] Part of transmission asm, item 54

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW (Continued)
FIGURE 8-1

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
61	866000	*Recorder Subasm (see Fig. 8-2)	
62		Same as Item 2	
63	231182	Nut Locking	
64	246388	Cover, Panel	
65	231183	Knob	
66	665563	Knob Asm	
67	665796	Cover Asm	
68	11-2873-20	Pen Asm, Event	
69	666587	Tubing, Event Pen	
70	11-2123-32	Event Marker Asm, RH	
71		Same as Item 68	
72	11-2123-31	Event Marker Asm, LH	
73	11-2823-33	Pen Asm, Analog	
74	667277	Tubing, Analog Pen	
75	246415	Nut, Knurled	
76	246422-1	Switch	S-305,S-306
77	10-241145-224	Capacitor [3]	C-303

[1] Model 15-6327-57,58 only
[2] Optional accessory equipment
[3] Model 15-6327-51 only
[4] Part of transmission asm, item 54

NOTE: Items marked with asterisk (*) are not available at this level.
Replace either components of the item or the next larger assembly.



BRUSH 220
FIG. 8-1

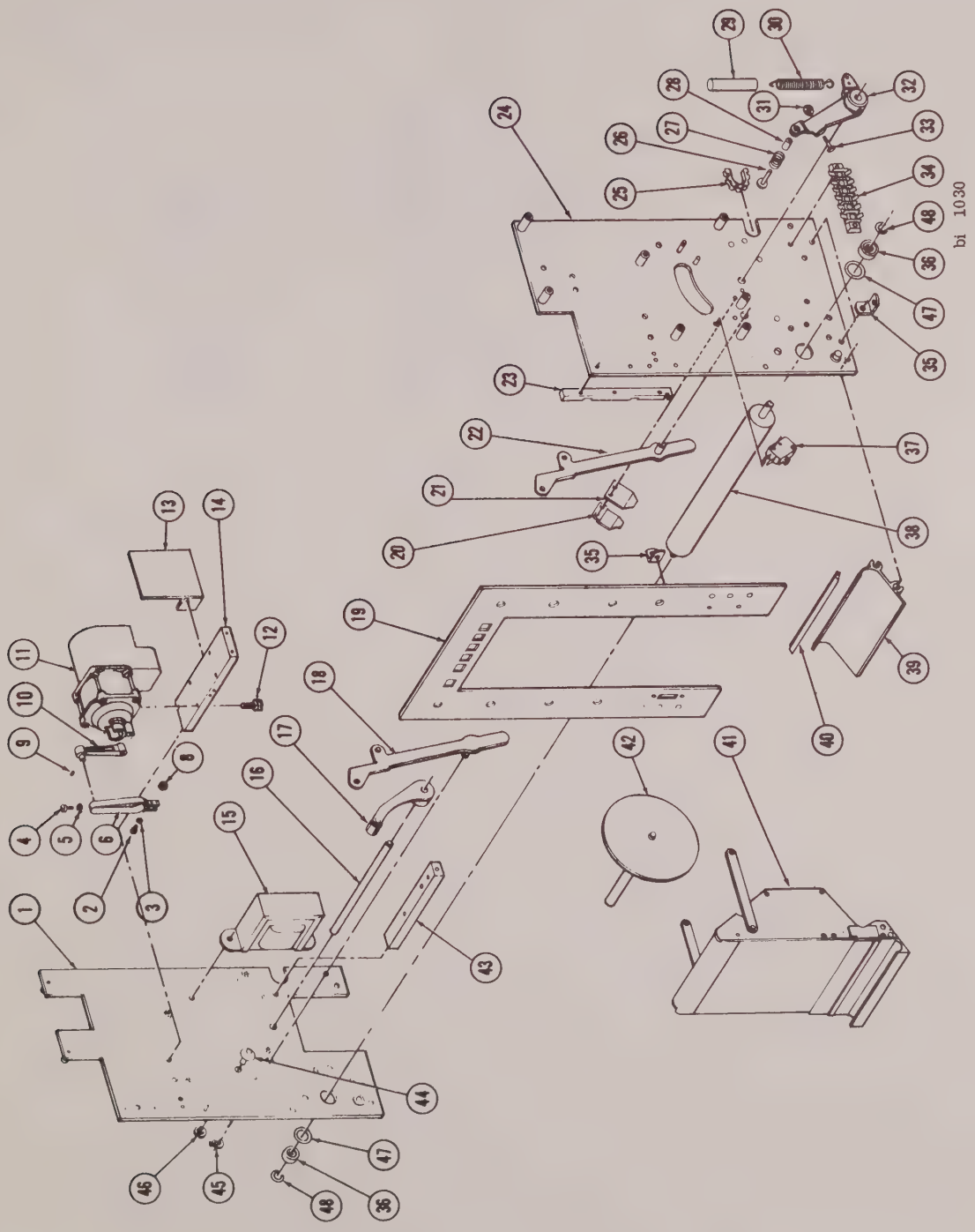
BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
RECORDER SUBASM 866000
FIGURE 8-2

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	865855	**Plate Asm, LH	
2	31-119922-2605	Screw	
3	11305-37	Washer	
4	31-241908-0002	Screw, Cap	
5	289583	Washer, Band Clamping	
6	680294	Band Asm	
7	Not Used		
8	31-129647-26	Nut, Hex	
9	31-121166-2602	Set Screw	
10	782332	Drive Arm Asm*	
11	881993	Penmotor Asm (includes items 2,3,4,5,6,8,9, & 10)	
12	31-119922-8210	Screw, Cap	
13	266871	Shield	
14	365506	Bar, Mounting Penmotor	
15	265542	Transformer	T-301
16	265975	Shaft, Straight	
17	743915-10	Arm Asm, Sensor	
18	681946	Lever Asm	
19	865715	Panel Asm, Front, Silkscreen (-50, -51, -55, -56)	
19	869667	Panel Asm, Front, Silkscreen (-57, -58)	
20	243623	Spring Positioning	
21	243622	Pad, Friction	
22	665789	Lever Asm, RH	
23	365792	Catch, Cover	
24	865852	**Plate Asm, RH	
25	2-128693-3	Grommet, Caterpillar	
26	643919-10	Disc Asm, Friction	
27	1-264521-2	Spring, Compression	
28	108400-15	Insulation, Sleeve	
29	130327-8	Insulation	
30	1-240031-3	Spring, Helical	
31	1-118195-304	Washer, Plain	
32	743913-10	Arm Subasm, Brake	
33	31-119924-6208	Screw Hex Head	
34	265814-6	Terminal Board	TB-301
35	1-265849-4	Bracket, Angle	
36	265741-1	Bearing	
37	266326	Switch, Sensitive	S-304
38	665593	Roll, Drive	
39	765507	Chute, Paper	
40	266014	Deflector, Paper	

*This part should only be replaced by an authorized Brush Service Representative
**Non replaceable item. Consult factory in event replacement is necessary.

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW (Continued)
RECORDER SUBASM 866000
FIGURE 8-2

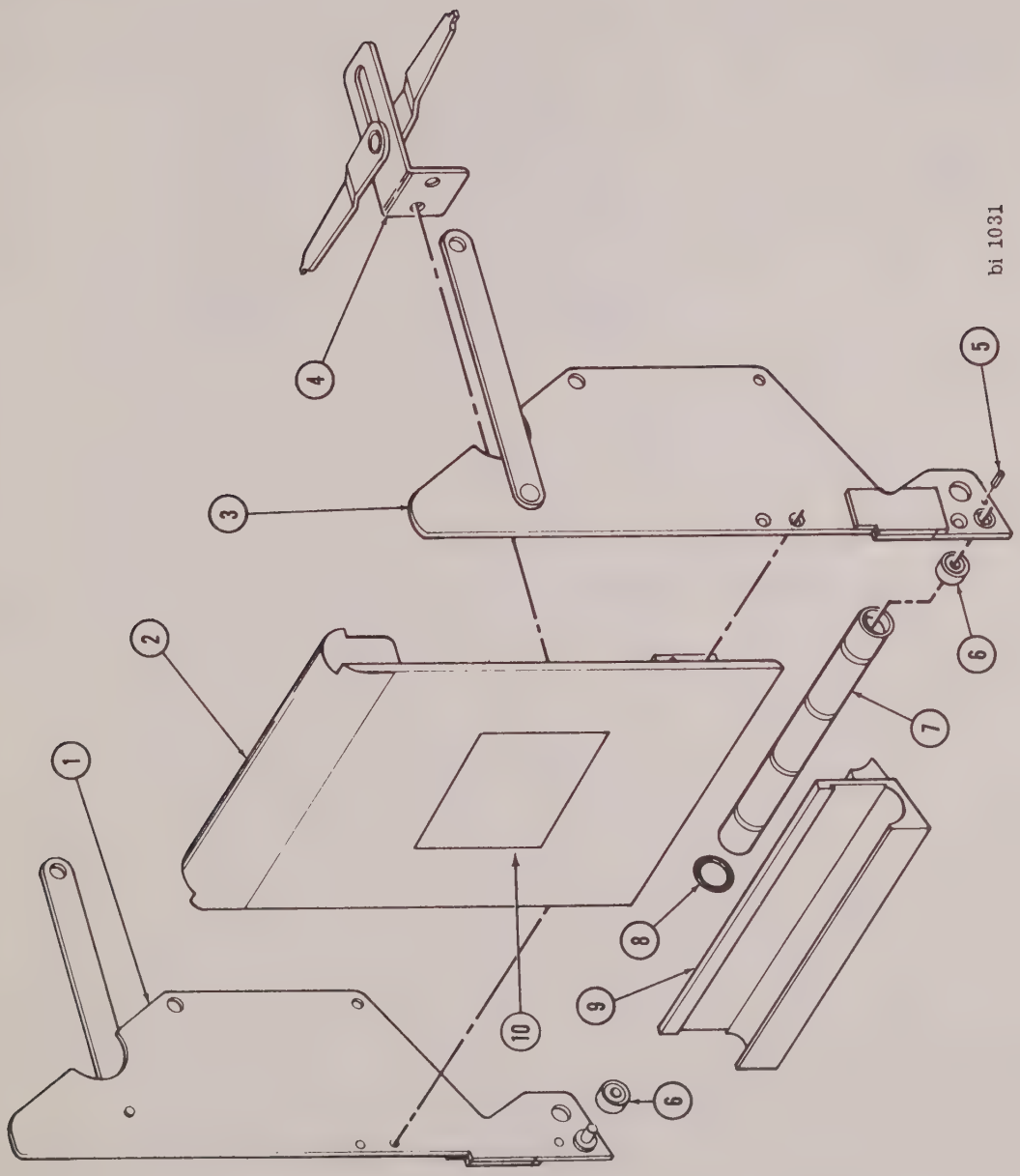
ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
41	865596	Table Asm, Writing (see Fig. 8-3)	
42	666465	Supply Roll Asm	
43	265860	Bar, Support	
44	243440	Bumper	
45	1-227070-9	Ring, Retaining	
46	243856-1	Nut, Push-on	
47	265745-1	Washer, Nylon	
48	240731-10	Ring, Retaining	



BRUSH 220
RECORDER SUBASSEMBLY
FIG. 8-2

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
WRITING TABLE ASM 865596
FIGURE 8-3

ITEM NO	PART NUMBER	DESCRIPTION
1	343617-910	Support Asm, Left
2	765585	Bar Asm, Writing
3	343616-910	Support Asm, Right
4	765591	Paper Release Asm
5	4-112468-21	Pin, Spring
6	1-210761-6	Bearing
7	365534	Roll, Pressure
8	243867-1	Packing, Preformed
9	665854	Bar Asm, Pull
10	466842-1	Label

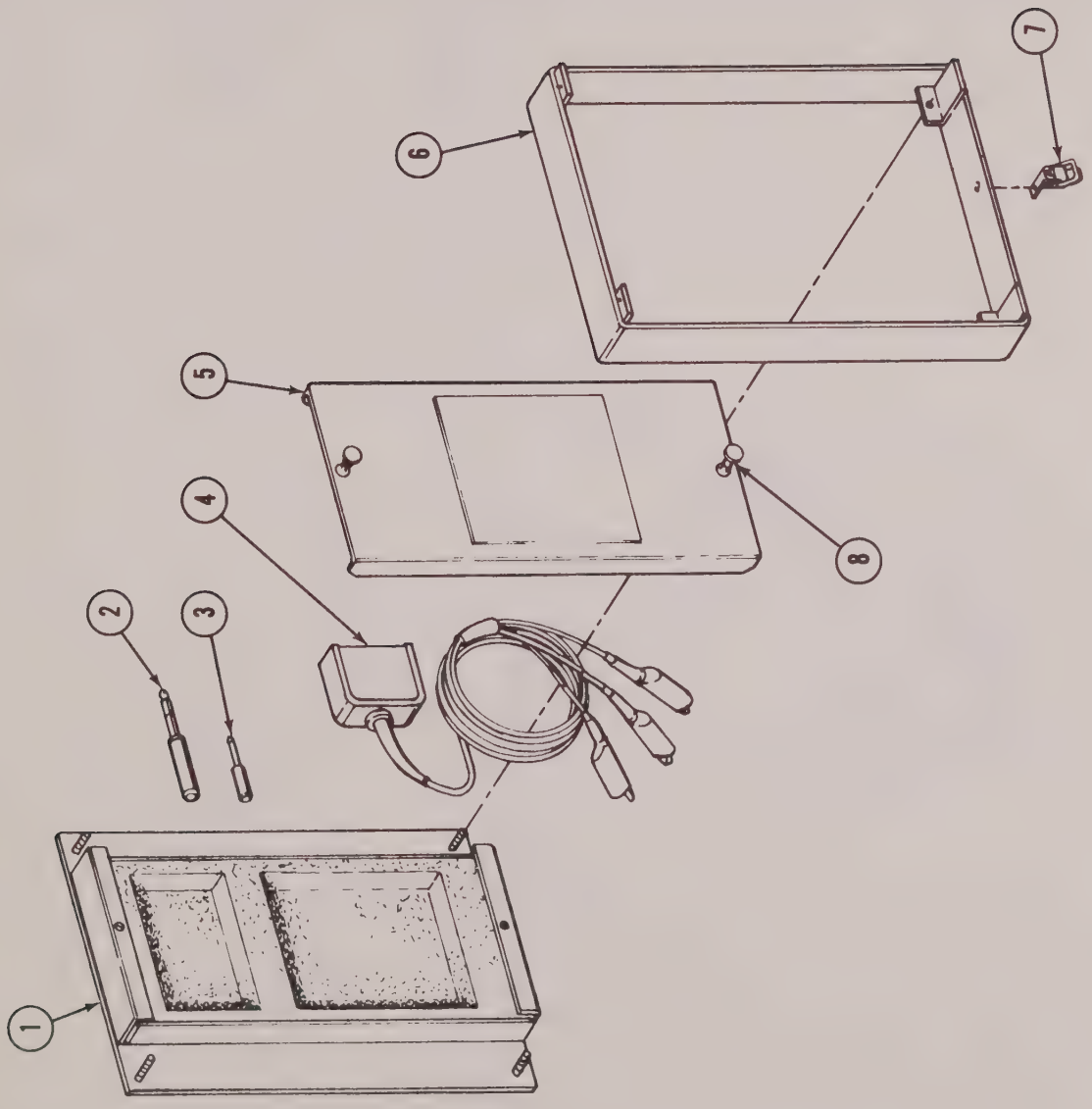


BRUSH 220
WRITING TABLE ASSEMBLY
FIG. 8-3

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
COVER ASM 11-6404-30 [1]
FIGURE 8-4

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	867226	Panel Subasm	
2	114816-15	Plug (24-28 Volts)	P-308
3	267379	Plug, Switch	P-309
4	11-6403-00	Converter, AC-DC	
5	367493	Cover	
6	867208	Cover Subasm	
7	267201-2	Fastener, Draw Bolt	
	267201-1	Latch (not shown)	
8	267490-2	Fastener	

[1] Used with Model 15-6327-51 only.



BRUSH 220
COVER ASSEMBLY
FIGURE 8-4

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
ACCESSORY ONE–SECOND TIMER, 11-6101-21
FIGURE 8-5

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	267186	Switch	S-102
2	364621	Cam	
3	267171	Bracket	
4	267154	Motor	B-101

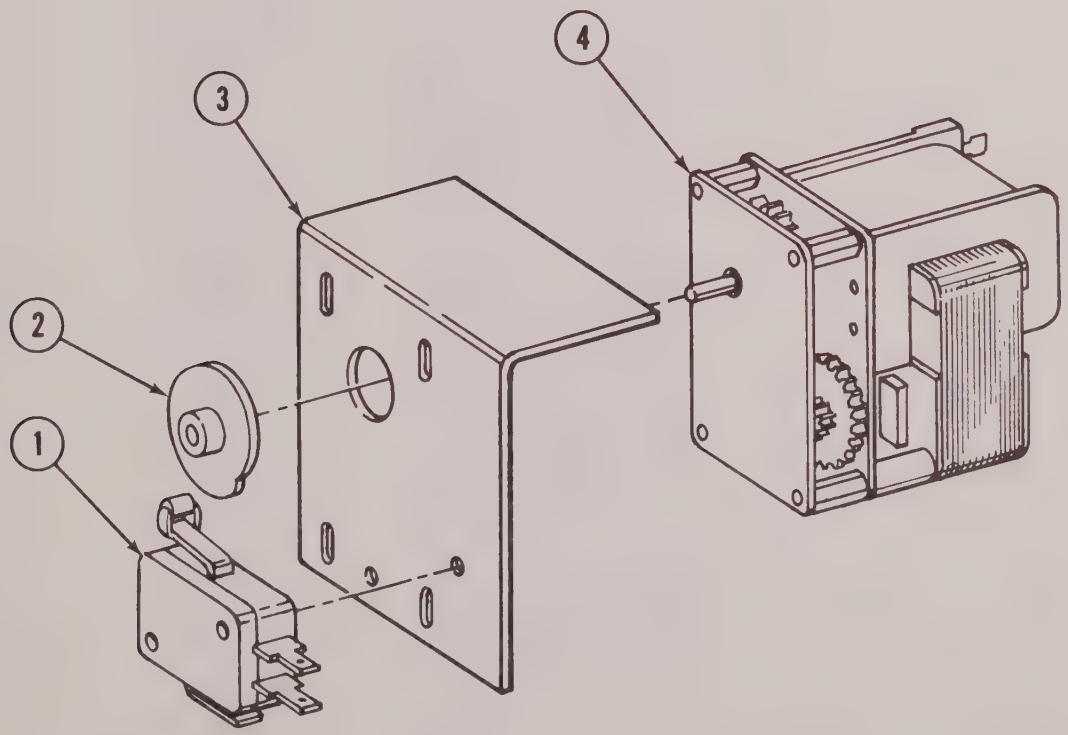


FIGURE 8-5 ONE-SECOND TIMER, MODEL 11-6101-21

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
NETWORK, DRIVE AMPLIFIER 869223
FIGURE 8-6

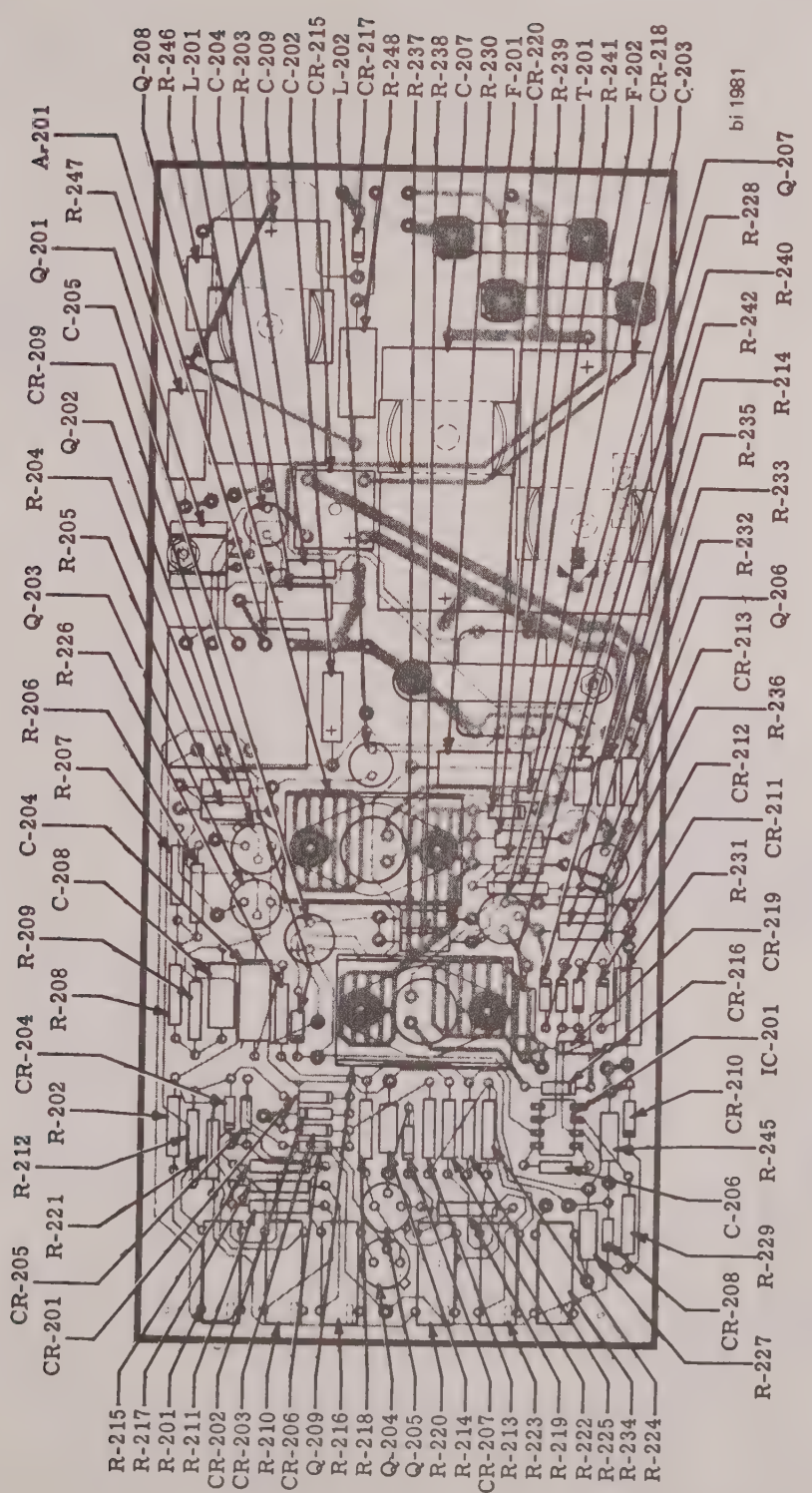
SYMBOL NO	PART NUMBER	DESCRIPTION
A-201	269062	Oscillator Module
C-201	231922-106	Capacitor
C-202	10-125904-203	Capacitor
C-203	243037-108	Capacitor
C-204	10-247116-333	Capacitor
C-205	269255-107	Capacitor
C-206	287614-101	Capacitor
C-207	243037-108	Capacitor
C-208	10-247116-153	Capacitor
C-209	241513-506	Capacitor
CR-201	244311	Semiconductor, Diode
CR-202	231869	Semiconductor, Diode
CR-203	244311	Semiconductor, Diode
CR-204	244311	Semiconductor, Diode
CR-205	231869	Semiconductor, Diode
CR-206	244311	Semiconductor, Diode
CR-207	231869	Semiconductor, Diode
CR-208	241133	Semiconductor, Diode
CR-209	10-244922-20	Semiconductor, Diode
CR-210	10-244922-20	Semiconductor, Diode
CR-211	244311	Semiconductor, Diode
CR-212	231869	Semiconductor, Diode
CR-213	231869	Semiconductor, Diode
CR-214	244311	Semiconductor, Diode
CR-215	265420-2	Rectifier, Bridge
CR-216	231887	Semiconductor, Diode
CR-217	269256-7	Semiconductor, Diode
CR-218	231887	Semiconductor, Diode
CR-219	231887	Semiconductor, Diode
CR-220	231887	Semiconductor, Diode
F-201	116198-7	Fuse
F-202	116198-7	Fuse
IC-201	230062-1	Semiconductor, IC
L-201	263453-1	Coil
L 202	263453-1	Coil
Q-201	230057-2	Transistor, 2N4922
Q-202	240236	Transistor, 2N1303
Q-203	240237	Transistor, 2N1302
Q-204	242323	Transistor
Q-205	240237	Transistor, 2N1302

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
NETWORK DRIVE AMPLIFIER 869223 (continued)
FIGURE 8-6

SYMBOL NO	PART NUMBER	DESCRIPTION
Q-206	242323	Transistor
Q-207	247149	Transistor
Q-208	267718-3	Transistor, 2N4900
Q-209	267716-3	Transistor, 2N4912
R-201	282299-502	Resistor, Variable
R-202	1-128182-3601	Resistor
R-203	5-115557-151	Resistor
R-204	5-115557-103	Resistor
R-205	5-115557-103	Resistor
R-206	1-128182-1502	Resistor
R-207	1-128182-1502	Resistor
R-208	1-128182-4701	Resistor
R-209	1-128182-2501	Resistor
R-210	282299-502	Resistor, Variable
R-211	1-128182-6801	Resistor
R-212	1-128182-91671	Resistor
R-213	1-128182-1103	Resistor
R-214	5-115557-822	Resistor
R-215	1-128182-1501	Resistor
R-216	282299-202	Resistor, Variable
R-217	1-128182-1501	Resistor
R-218	1-128182-5002	Resistor
R-219	1-128182-3901	Resistor
R-220	282299-202	Resistor, Variable
R-221	1-128182-2501	Resistor
R-222	1-128182-5601	Resistor
R-223	282299-502	Resistor, Variable
R-224	1-128182-5601	Resistor
R-225	1-128182-1103	Resistor
R-226	1-128182-2702	Resistor
R-227	5-115557-273	Resistor
R-228	1-128182-5003	Resistor
R-229	1-128182-5002	Resistor
R-230	5-115558-181	Resistor
R-231	5-115558-271	Resistor
R-232	5-115557-183	Resistor
R-233	5-115557-183	Resistor
R-234	282299-103	Resistor, Variable
R-235	5-115557-471	Resistor
R-236	5-115557-471	Resistor
R-237	5-115557-471	Resistor
R-238	5-115557-471	Resistor
R-239	5-115557-332	Resistor
R-240	5-115557-332	Resistor

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
NETWORK DRIVE AMPLIFIER 869223 (continued)
FIGURE 8-6

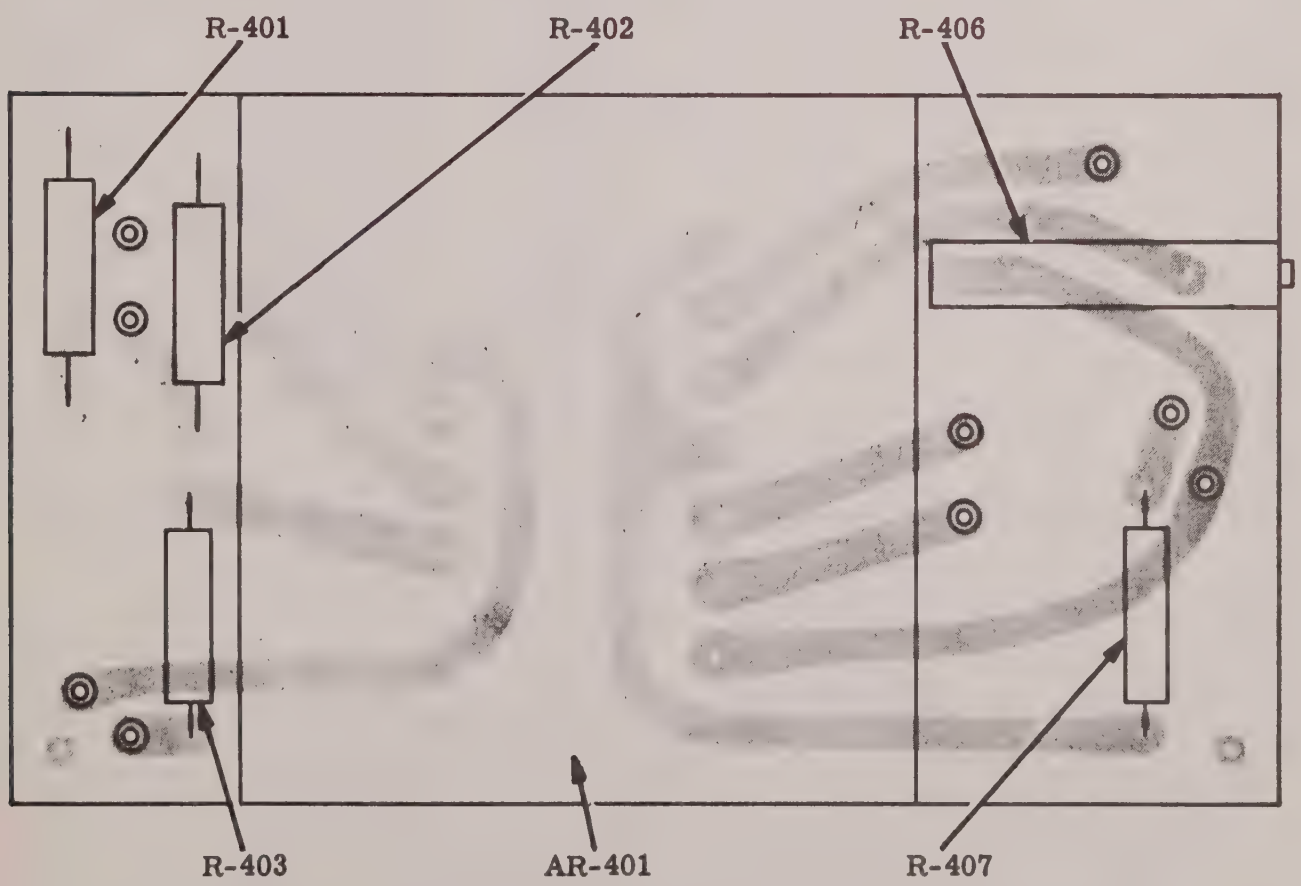
SYMBOL NO	PART NUMBER	DESCRIPTION
R-241	5-115557-103	Resistor
R-242	5-115557-122	Resistor
R-243	Not Used	
R-244	Not Used	
R-245	5-115557-102	Resistor
R-246	5-115558-220	Resistor
R-247	5-115559-152	Resistor
R-248	5-115559-152	Resistor
T-201	263516	Transformer
Not shown	265763-3	Male Contact(mates to 265760-2)



BRUSH 220
NETWORK ASSEMBLY
FIGURE 8-6

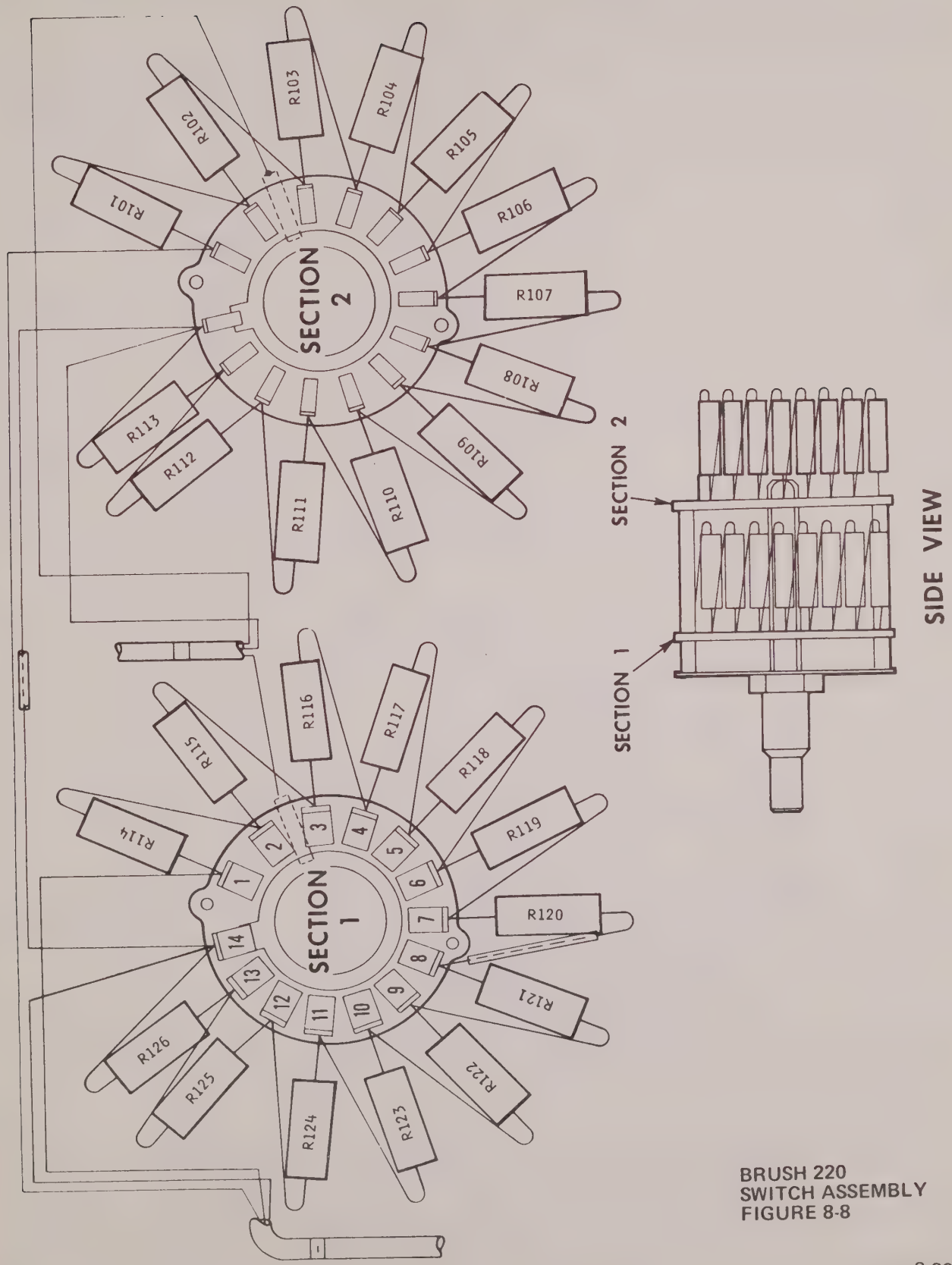
BRUSH 220 RECORDER
ALL MODELS -- EXPLODED VIEW
PREAMPLIFIER ASM 766409
FIGURE 8-7

SYMBOL NO	PART NUMBER	DESCRIPTION
AR-401	266002	Transducer Amplifier
R-401	1-117802-5003	Resistor
R-402	1-117802-5003	Resistor
R-403	1-128182-1001	Resistor
R-406	266337-503	Resistor, Variable
R-407	5-115557-331	Resistor



BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
SWITCH ASM 865977
FIGURE 8-8

SYMBOL NO	PART NUMBER	DESCRIPTION
R-101	50-128182-2504	Resistor
R-102	50-128182-1504	Resistor
R-103	50-128182-5003	Resistor
R-104	50-128182-2503	Resistor
R-105	50-128182-1503	Resistor
R-106	50-128182-5002	Resistor
R-107	50-128182-2502	Resistor
R-108	50-128182-1502	Resistor
R-109	50-128182-5001	Resistor
R-110	50-128182-2501	Resistor
R-111	50-128182-1501	Resistor
R-112	50-128182-5000	Resistor
R-113	50-128182-5000	Resistor
R-114	50-128182-2504	Resistor
R-115	50-128182-1504	Resistor
R-116	50-128182-5003	Resistor
R-117	50-128182-2503	Resistor
R-118	50-128182-1503	Resistor
R-119	50-128182-5002	Resistor
R-120	50-128182-2502	Resistor
R-121	50-128182-1502	Resistor
R-122	50-128182-5001	Resistor
R-123	50-128182-2501	Resistor
R-124	50-128182-1501	Resistor
R-125	50-128182-5000	Resistor
R-126	50-128182-5000	Resistor
S-101	265504	Switch

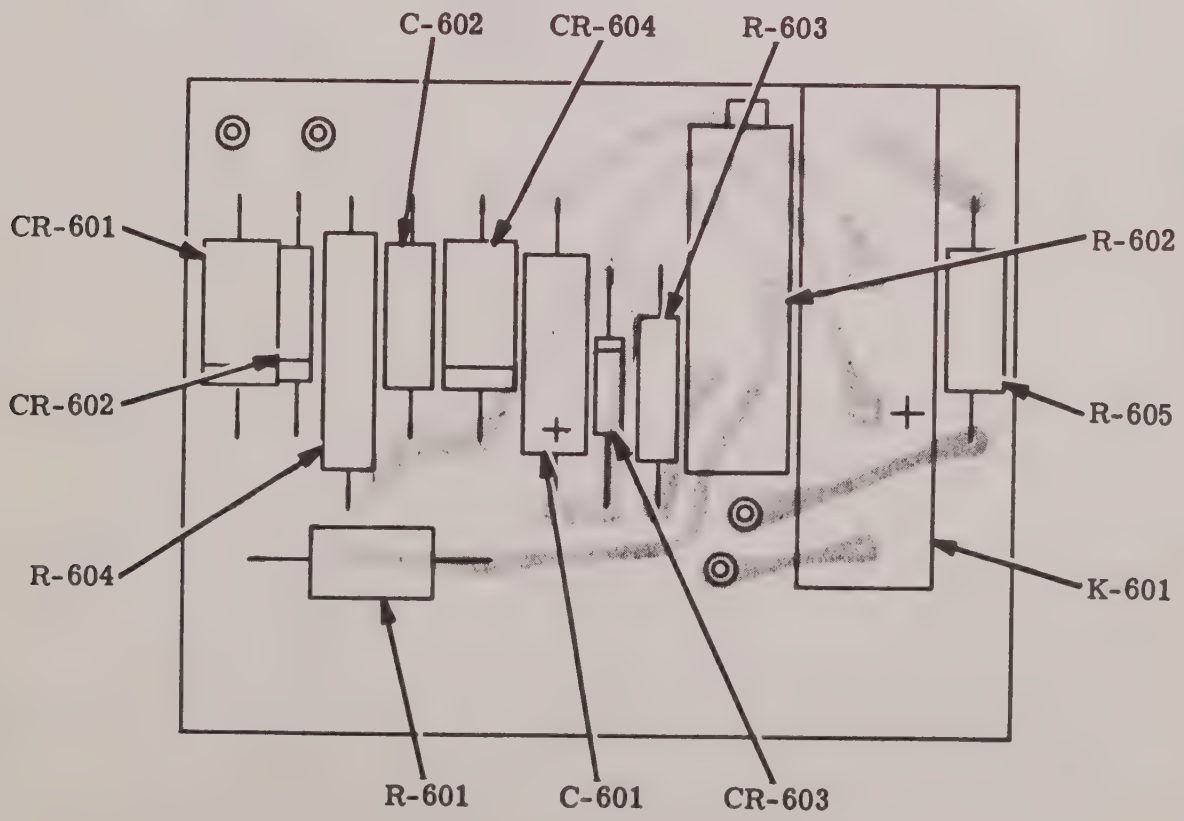


BRUSH 220
SWITCH ASSEMBLY
FIGURE 8-8

BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
NETWORK ASM, 1/10TH SECOND TIMER [1]
FIGURE 8-9

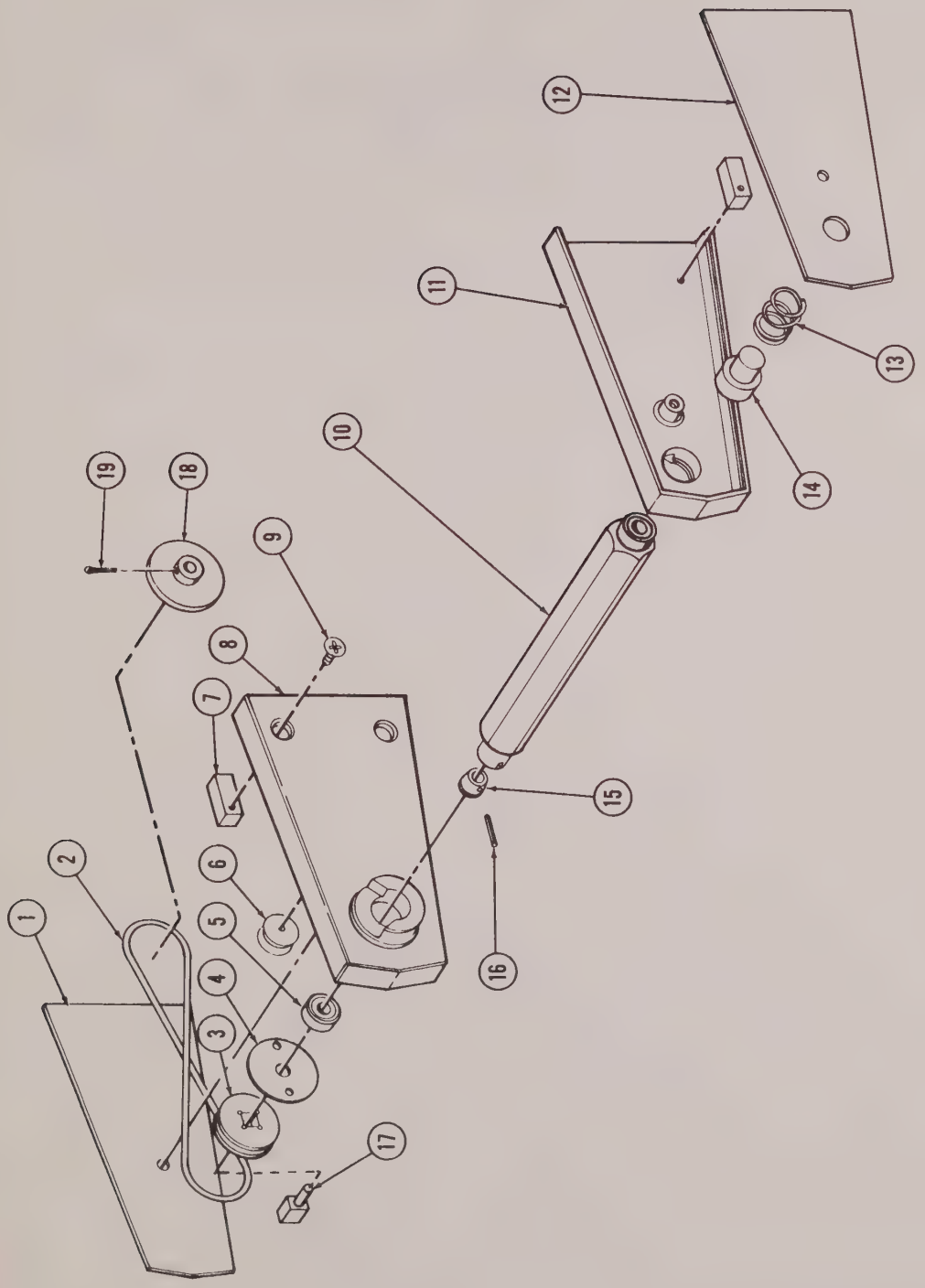
SYMBOL NO	PART NUMBER	DESCRIPTION
C-601	10-243601-685	Capacitor
C-602	240352-102	Capacitor
CR 601	130198-1	Diode, 1N2069
CR-602	244477	Diode, 1N981B
CR 603	243481	Diode, 4E040
CR-604	130198-1	Diode, 1N2069
K-601	267200	Relay, Reed
R 601	5-115557-272	Resistor
R-602	244771-502	Resistor, Variable
R 603	5-115557-392	Resistor
R-604	5-115558-331	Resistor
R-605	5-115557-220	Resistor

[1] Used with Model 15-6327-51 only



BRUSH 220 RECORDER
ALL MODELS – EXPLODED VIEW
ACCESSORY CHART TAKEUP ASM – 11-6402-03
FIGURE 8-10

ITEM NO	PART NUMBER	DESCRIPTION
1	249618-1	Plate Cover, Left
2	243867-5	O Ring
3	267257	Pulley
4	243696	Retainer, Bearing
5	1-210761-7	Bearing
6	246651	Roller, Guide
7	246307	Block
8	767254-3	Arm Asm, LH
9	3-249640-8206	Screw, Flat Head
10	666123	Shaft Asm (includes bearing part no. 230069-1)
11	767249-3	Arm Asm, RH
12	249617-1	Plate Cover, Left
13	267253	Spring Compression
14	266184	Shaft, Shouldered
15	243740	Collar
16	4-112468-14	Pin, Roll
17	266053	Shaft
18	266046	Pulley
19	236865-3	Pin, Cotter



BRUSH 220
CHART TAKEUP ASSEMBLY
FIGURE 8-10

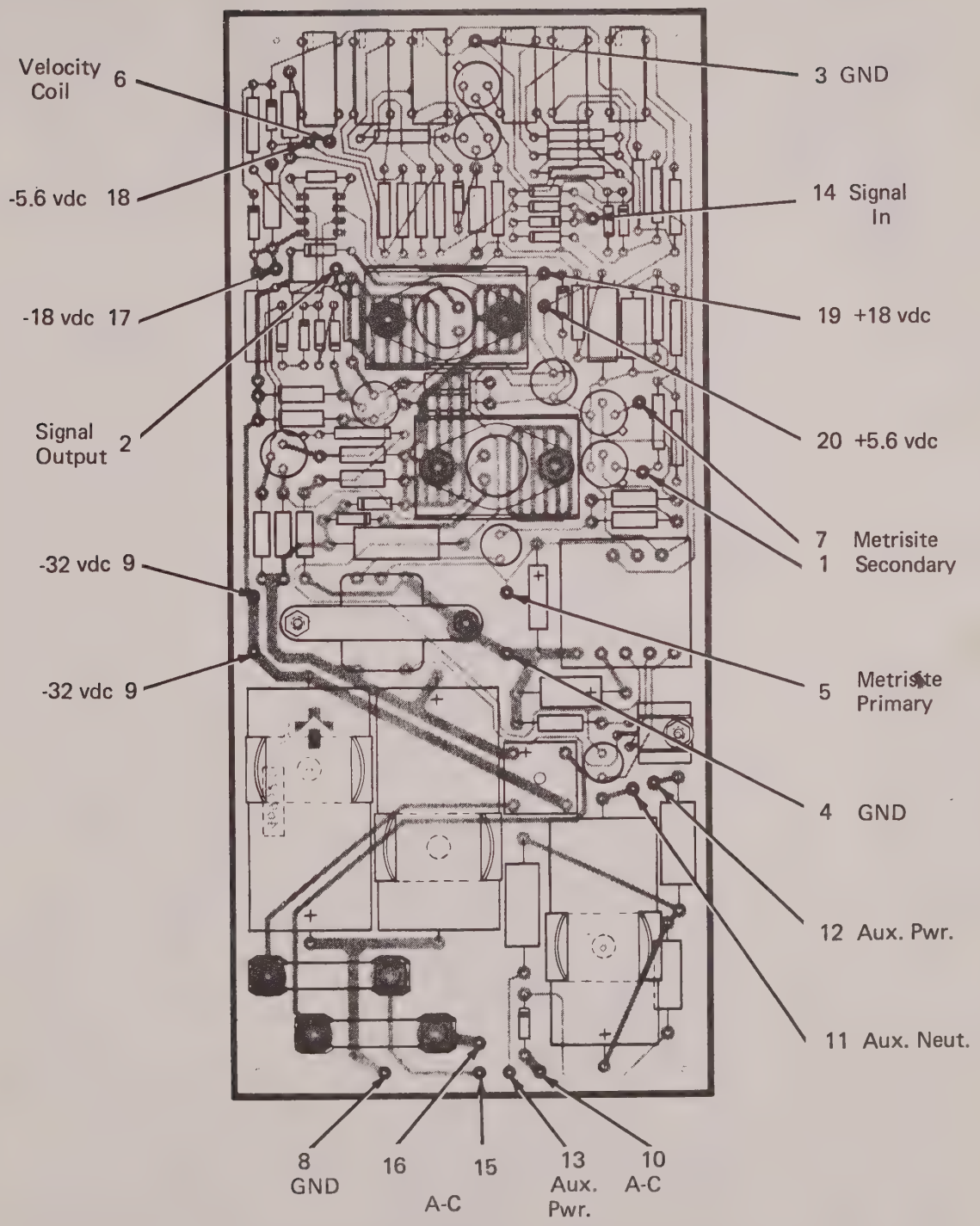
SECTION IX

SCHEMATICS

9.1 GENERAL

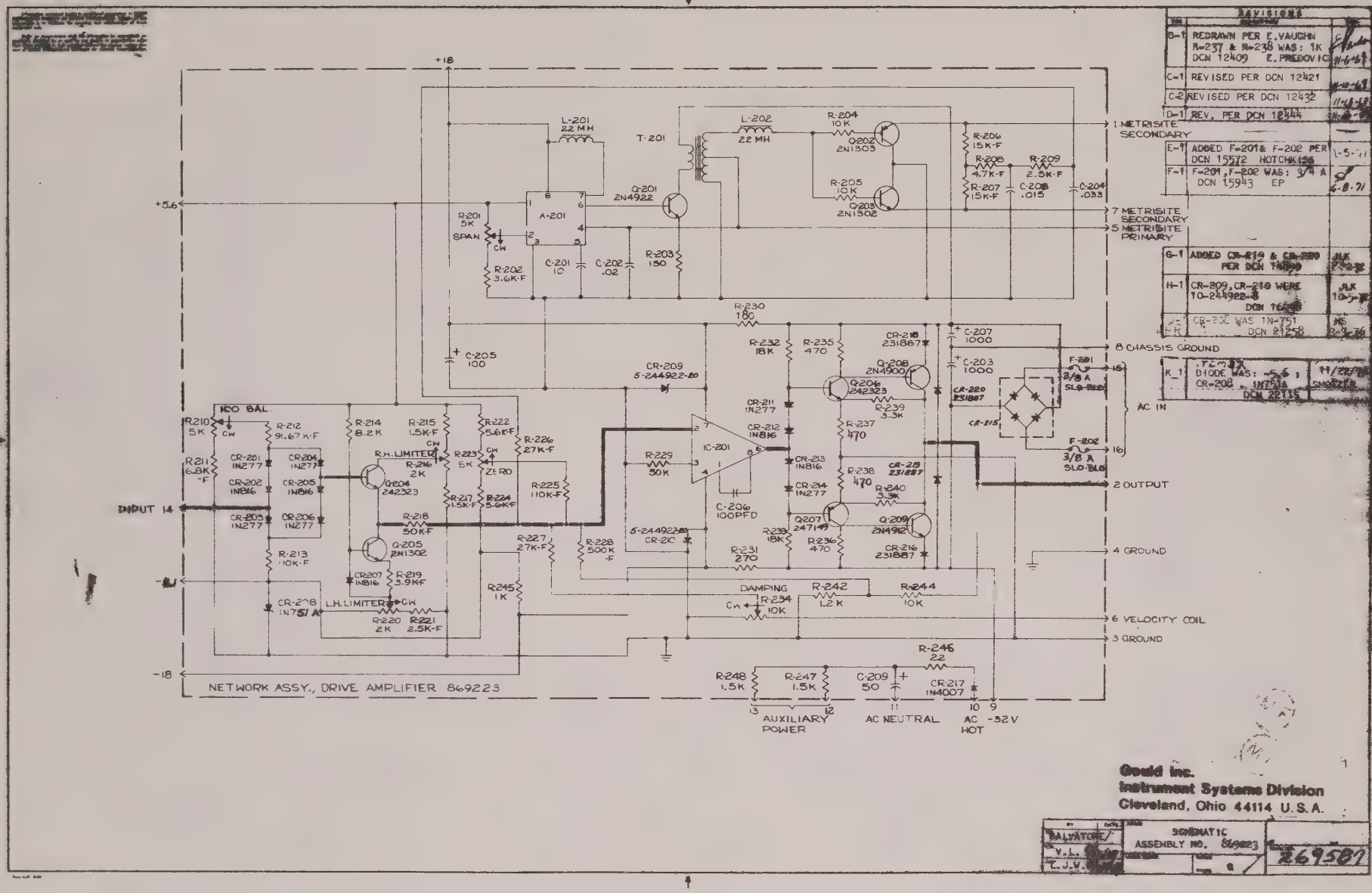
This section contains the schematics for all of the standard recorders and their components and accessories. The following table lists each model number and the appropriate schematic.

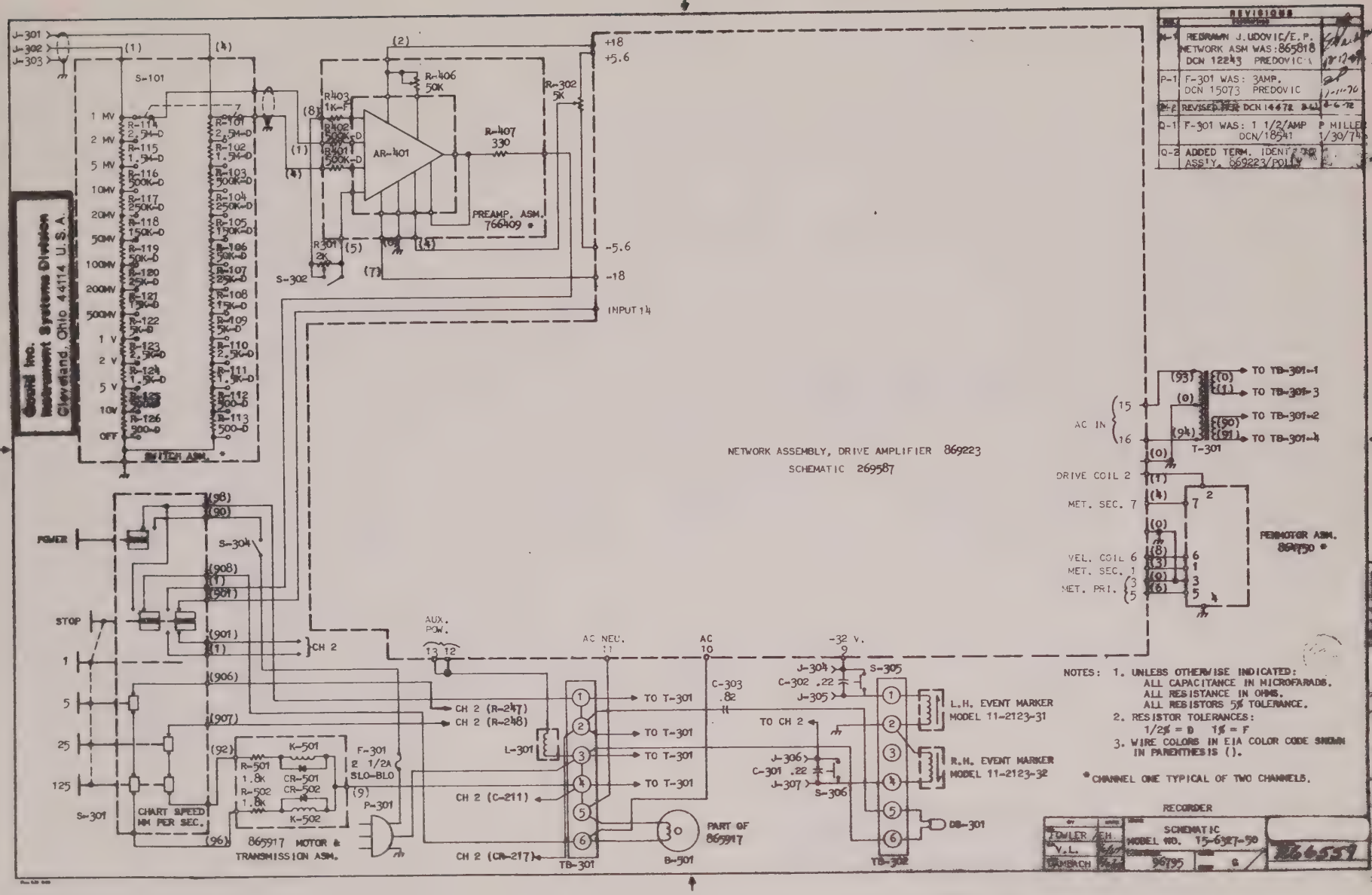
MODEL NO.	SCHEMATIC NO.
15-6327-50	266559
15-6327-51	267486
15-6327-55	266918
15-6327-56	266921
15-6327-57	269684
15-6327-58	266192
11-6221-00 (Event Marker)	267224
11-6101-21 (1 sec. Timer)	267216
869223 (Drive Board)	269587

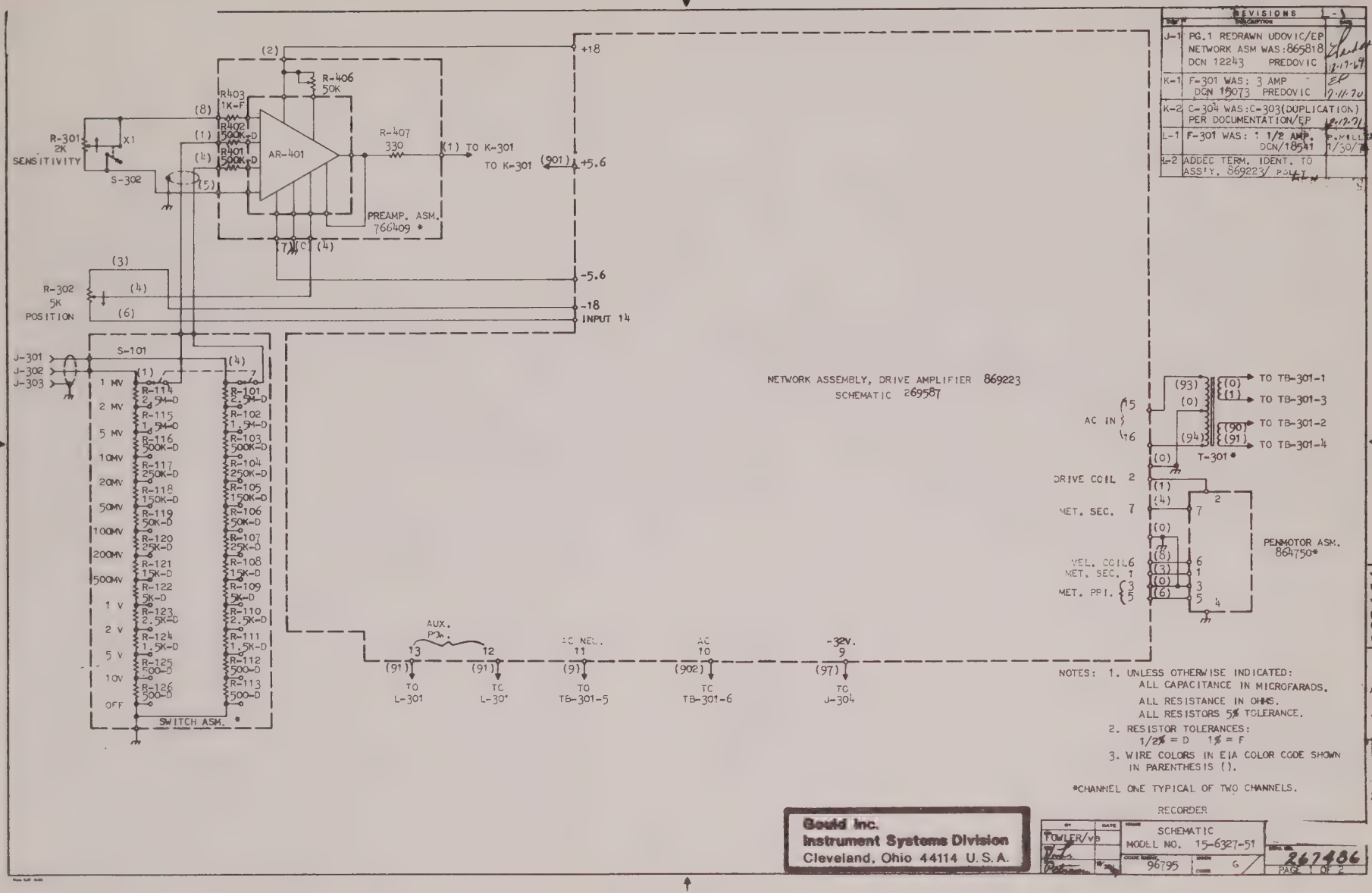


The numbers and voltages on this page refer to the numbers and voltages on schematic 269587.

FIGURE 9-1 DRIVE BOARD PIN CONNECTIONS


REVISIONS
B-1 REDRAWN PER E. VAUGHN R=237 & R=238 WAS: 1K DCN 12409 E. PREDOVIC
C-1 REVISED PER DCN 12421
C-2 REVISED PER DCN 12432
D-1 REV. PER DCN 12444
E-1 ADDED F-201& F-202 PER DCN 15572 HOTCHK'D
F-1 F-201,F-202 WAS: 3/4 A DCN 15943 EP
G-1 ADDED CR-219 & CR-220 PER DCN
H-1 CR-209,CR-210 WERE TO-2449223-8 DCN
J-1 CR-220 WAS 1N-751 DCN 21258
K-1 DIODE WAS: -5.6 ; CR-208 , 1N751A DCN 28105
+18
+5.6
-18
INPUT 14
L-201 22 MH
T-201
L-202 22 MH
R-204 10K
Q-202 2N1305
R-205 10K
Q-203 2N1302
Q-201 2N4922
A-201
R-201 5K SPAN
R-202 3.6K-F
C-201 10
C-202 .02
R-203 150
R-206 15K-F
R-208 4.7K-F
R-209 2.5K-F
R-207 15K-F
C-208 .015
C-204 .033
1 METRISITE SECONDARY
7 METRISITE SECONDARY
5 METRISITE PRIMARY
R-230 180
C-205 100
R-232 18K
R-235 470
CR-218 231887
C-207 1000
C-203 1000
8 CHASSIS GROUND
F-201 3/8 A SLO-BLO
15
AC IN
F-202 3/8 A SLO-BLO
16
CR-209 5-244922-80
Q-208 2N4900
Q-206 242323
R-239 3.3K
CR-211 1N277
CR-212 1N816
R-237 470
CR-213 1N816
R-238 470
CR-219 231887
CR-214 1N277
R-240 3.3K
Q-207 247149
Q-209 2N4912
R-233 18K
R-236 470
CR-216 231887
2 OUTPUT
4 GROUND
IC-201
C-206 100PFD
5-244923-80 CR-210
R-231 270
R-229 30K
ICO BAL.
R-210 5K CW
R-211 6.8K -F
R-212 91.67 K-F
R-214 8.2 K
R-215 1.5K-F CW
R-222 5.6K-F
R-223 5K CW ZERO
R-224 5.6K-F
R-226 27K-F
R-225 110K-F
R-227 27K-F
R-228 500K -F
R-213 10K-F
CR-201 1N277
CR-202 1N816
CR-204 1N277
CR-205 1N816
CR-203 1N277
CR-206 1N277
R.H. LIMITER
R-216 2K
Q-204 242323
R-218 50K-F
Q-205 2N1302
CR-207 1N816
R-219 5.9K-F
CR-208 1N751A
L.H. LIMITER CW
R-220 2K
R-221 2.5K-F
R-245 1K
DAMPING
R-234 10K CW
R-242 1.2 K
R-244 10K
6 VELOCITY COIL
3 GROUND
R-246 22
R-248 1.5K
R-247 1.5K
C-209 50
CR-217 1N4007
13 12 11 10 9
AUXILIARY POWER
AC NEUTRAL
AC HOT
-32 V
NETWORK ASSY., DRIVE AMPLIFIER 869223
Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.
SALVATORE
V.L.
T.J.V.
SCHEMATIC
ASSEMBLY NO. 869223
269587


Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.
S-101
ATTEN ASM.
AR-401
PREAMP. ASM. 766409 *
R-406 50K
R-407 330
R-302 5K
R403 1K-F
R402 500K-D
R401 500K-D
R301 2K
S-302
+18
+5.6
-5.6
-18
INPUT 14
NETWORK ASSEMBLY, DRIVE AMPLIFIER 869223
SCHEMATIC 269587
AC IN
T-301
TO TB-301-1
TO TB-301-3
TO TB-301-2
TO TB-301-4
DRIVE COIL 2
MET. SEC. 7
VEL. COIL 6
MET. SEC. 1
MET. PRI.
PENMOTOR ASM. 869750 *
POWER
S-304
STOP
S-301
CHART SPEED MM PER SEC.
865917 MOTOR & TRANSMISSION ASM.
K-501
K-502
CR-501
CR-502
R-501 1.8K
R-502 1.8K
F-301 2 1/2A SLO-BLO
P-301
CH 2
AUX. POW.
AC NEU.
AC
-32 V.
CH 2 (R-247)
CH 2 (R-248)
CH 2 (C-211)
CH 2 (CR-217)
L-301
TO T-301
C-303 .82
TO CH 2
J-304
J-305
J-306
J-307
C-302 .22
C-301 .22
S-305
S-306
L.H. EVENT MARKER MODEL 11-2123-31
R.H. EVENT MARKER MODEL 11-2123-32
DB-301
TB-301
TB-302
B-501
PART OF 865917
NOTES: 1. UNLESS OTHERWISE INDICATED:
ALL CAPACITANCE IN MICROFARADS.
ALL RESISTANCE IN OHMS.
ALL RESISTORS 5% TOLERANCE.
2. RESISTOR TOLERANCES:
1/2% = D 1% = F
3. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).
* CHANNEL ONE TYPICAL OF TWO CHANNELS.
REVISIONS
M-1 REDRAWN J. UDOVIC/E. P. NETWORK ASM WAS: 865818 DCN 12243 PREDOVIC
P-1 F-301 WAS: 3AMP. DCN 15073 PREDOVIC
P-2 REVISED PER DCN 14478
Q-1 F-301 WAS: 1 1/2 AMP DCN/18541 P MILLER 1/30/74
Q-2 ADDED TERM. IDENT. ASS'Y. 869223/P01
RECORDER
SCHEMATIC
MODEL NO. T5-6387-50
96795
B
TOWLER
V.L.
TAMBACH
B6455


REVISIONS
J-1 PG.1 REDRAWN UDOVIC/EP NETWORK ASM WAS:865818 DCN 12243 PREDOVIC 1-17-69
K-1 F-301 WAS: 3 AMP DCN 15073 PREDOVIC EP 2-11-70
K-2 C-304 WAS:C-303(DUPLICATION) PER DOCUMENTATION/EP 6-17-71
L-1 F-301 WAS: 1 1/2 AMP. DCN/18541 P.MILLS 1/30/7
4-2 ADDED TERM. IDENT. TO ASS'Y. 869223/ POL
R-301 2K SENSITIVITY
X1
S-302
R403 1K-F
R402 500K-D
R401 500K-D
AR-401
R-406 50K
R-407 330
(1) TO K-301
TO K-301 (901)
PREAMP. ASM. 766409 *
+18
+5.6
-5.6
-18
INPUT 14
R-302 5K POSITION
S-101
J-301
J-302
J-303
1 MV
2 MV
5 MV
10MV
20MV
50MV
100MV
200MV
500MV
1 V
2 V
5 V
10V
OFF
R-114 2.5M-D
R-115 1.5M-D
R-116 500K-D
R-117 250K-D
R-118 150K-D
R-119 50K-D
R-120 25K-D
R-121 15K-D
R-122 5K-D
R-123 2.5K-D
R-124 1.5K-D
R-125 500-D
R-126 500-D
R-101 2.5M-D
R-102 1.5M-D
R-103 500K-D
R-104 250K-D
R-105 150K-D
R-106 50K-D
R-107 25K-D
R-108 15K-D
R-109 5K-D
R-110 2.5K-D
R-111 1.5K-D
R-112 500-D
R-113 500-D
SWITCH ASM. *
NETWORK ASSEMBLY, DRIVE AMPLIFIER 869223
SCHEMATIC 269587
AUX. PWR.
13
12
11
10
9
(91) TO L-301
(91) TO L-30*
(9) TO TB-301-5
(902) TO TB-301-6
(97) TO J-304
AC IN
15
16
(93)
(94)
(0)
(1)
(90)
(91)
TO TB-301-1
TO TB-301-3
TO TB-301-2
TO TB-301-4
T-301 *
DRIVE COIL 2
MET. SEC. 7
VEL. COIL 6
MET. SEC. 1
MET. PPI. 3 5
PENMOTOR ASM. 864750*
NOTES: 1. UNLESS OTHERWISE INDICATED:
ALL CAPACITANCE IN MICROFARADS.
ALL RESISTANCE IN OHMS.
ALL RESISTORS 5% TOLERANCE.
2. RESISTOR TOLERANCES:
1/2% = D 1% = F
3. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).
*CHANNEL ONE TYPICAL OF TWO CHANNELS.
RECORDER
Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.
FOWLER/VB
SCHEMATIC
MODEL NO. 15-6327-51
96795
G
267486
PAGE 1 OF 2

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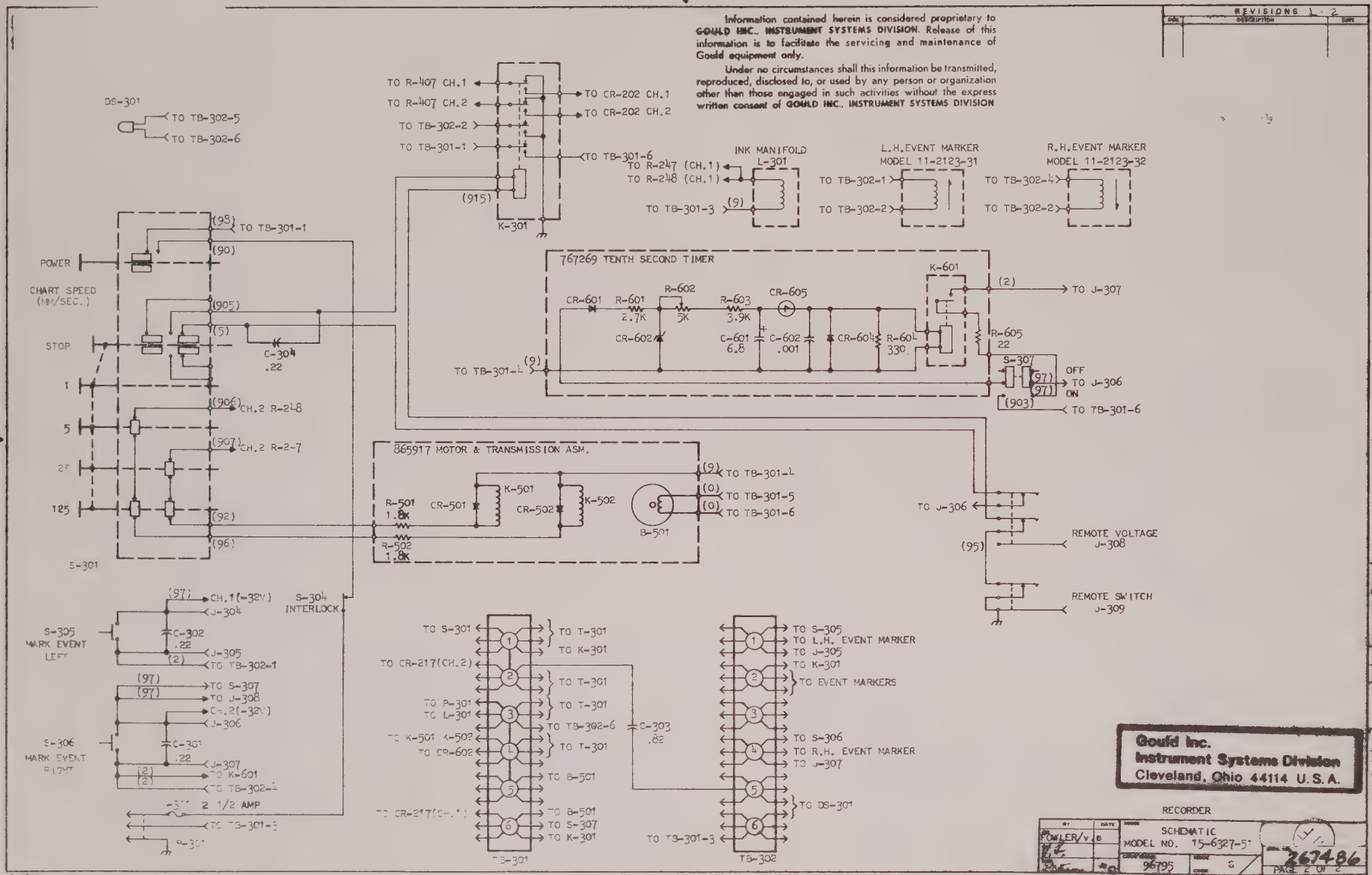
REVISIONS

PAR.	DESCRIPTION	DATE



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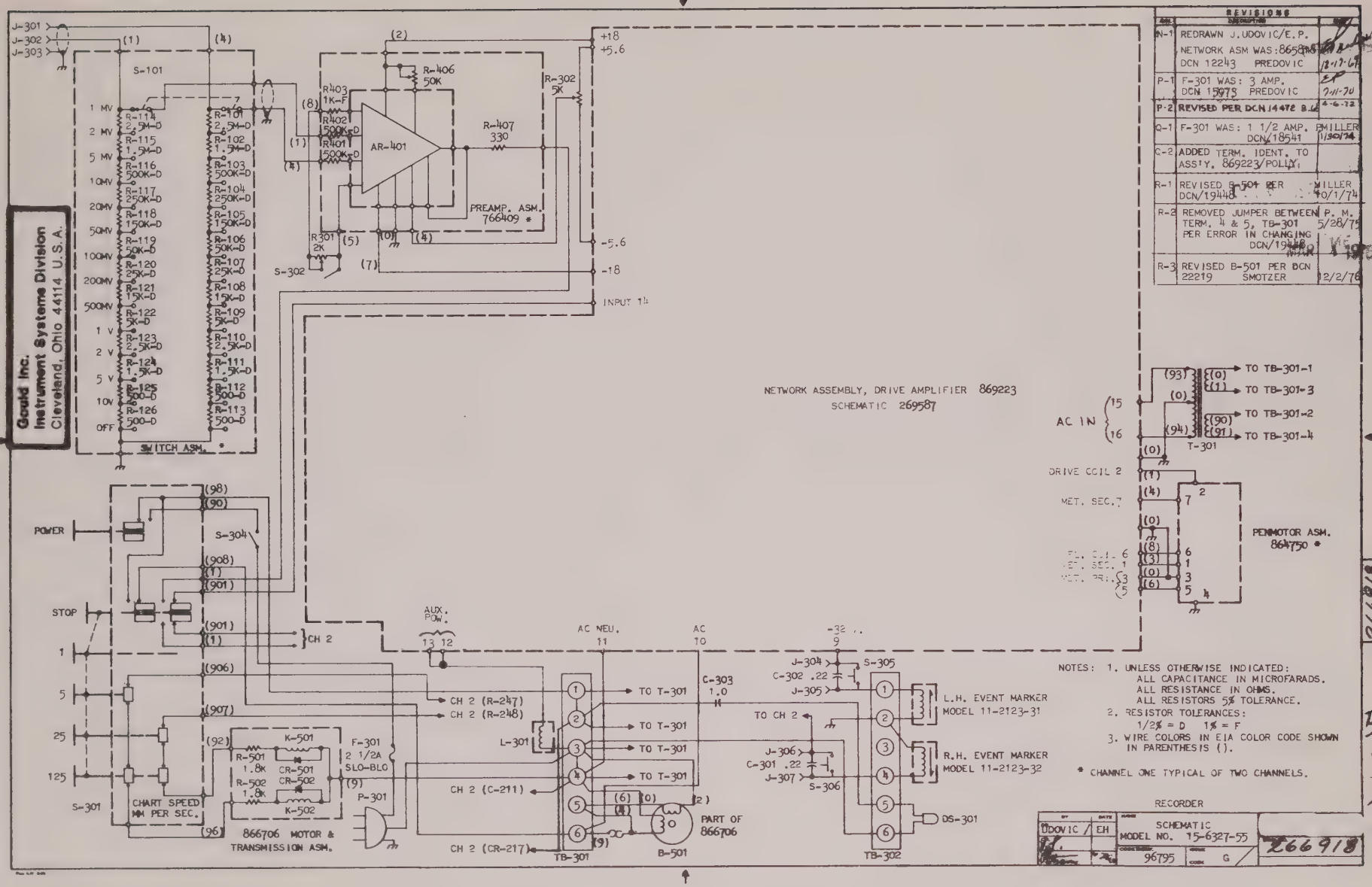
RECORDER

BY	DATE	
FOWLER/V	8	SCHEMATIC MODEL NO. 15-6327-5?
		96795 G

267486

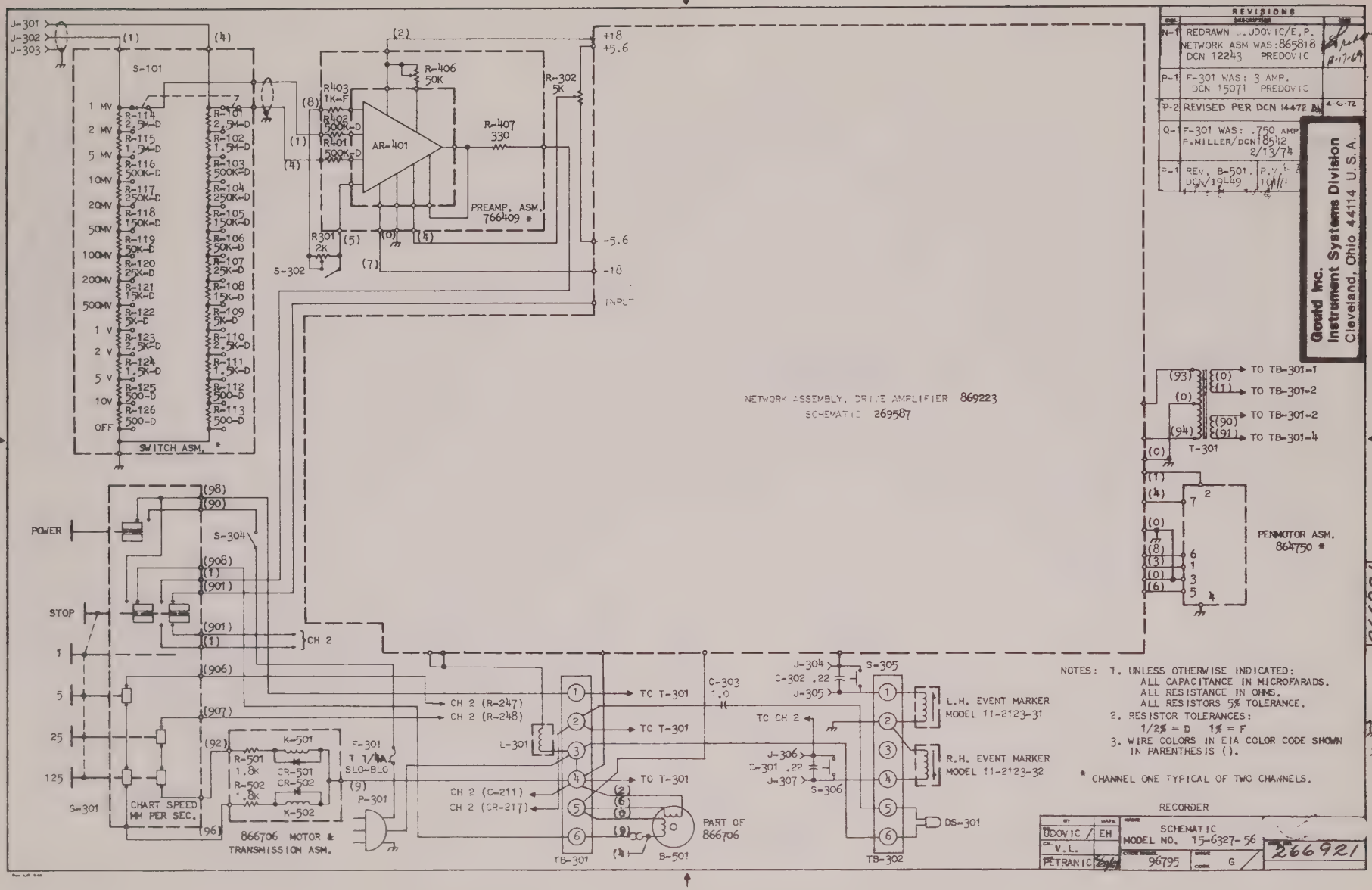
PAGE 2 OF 2



REVISIONS		
N-1	REDRAWN J.UDOVIC/E.P. NETWORK ASM WAS:865[illegible] DCN 12243 PREDOVIC	12-7-67
P-1	F-301 WAS: 3 AMP. DCN 15[illegible] PREDOVIC	2-11-70
P-2	REVISED PER DCN 14472 B.C.	4-6-72
Q-1	F-301 WAS: 1 1/2 AMP. DCN 18541	MILLER 1/30/74
C-2	ADDED TERM. IDENT. TO ASS'Y. 869223/POLLY	
R-1	REVISED B-501 PER DCN/19[illegible]	MILLER 10/1/74
R-2	REMOVED JUMPER BETWEEN TERM. 4 & 5, TB-301 PER ERROR IN CHANGING DCN/19[illegible]	P. M. 5/28/75
R-3	REVISED B-501 PER DCN 22219 SMOTZER	12/2/76

UDOVIC	EH	SCHEMATIC MODEL NO. 15-6327-55	266918
		96795	G

266918



NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL CAPACITANCE IN MICROFARADS.
   ALL RESISTANCE IN OHMS.
   ALL RESISTORS 5% TOLERANCE.
2. RESISTOR TOLERANCES:
   1/2% = D 1% = F
3. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ().

* CHANNEL ONE TYPICAL OF TWO CHANNELS.

REVISIONS			
N-1	REDRAWN U.UDOVIC/E.P. NETWORK ASM WAS:865818 DCN 12243 PREDOVIC		8-17-69
P-1	F-301 WAS: 3 AMP. DCN 15071 PREDOVIC		
P-2	REVISED PER DCN 14472	BA	4-6-72
Q-1	F-301 WAS: .750 AMP P.MILLER/DCN 18542 2/13/74		
R-1	REV. B-501. DCN 19149	P.V.	10/7/

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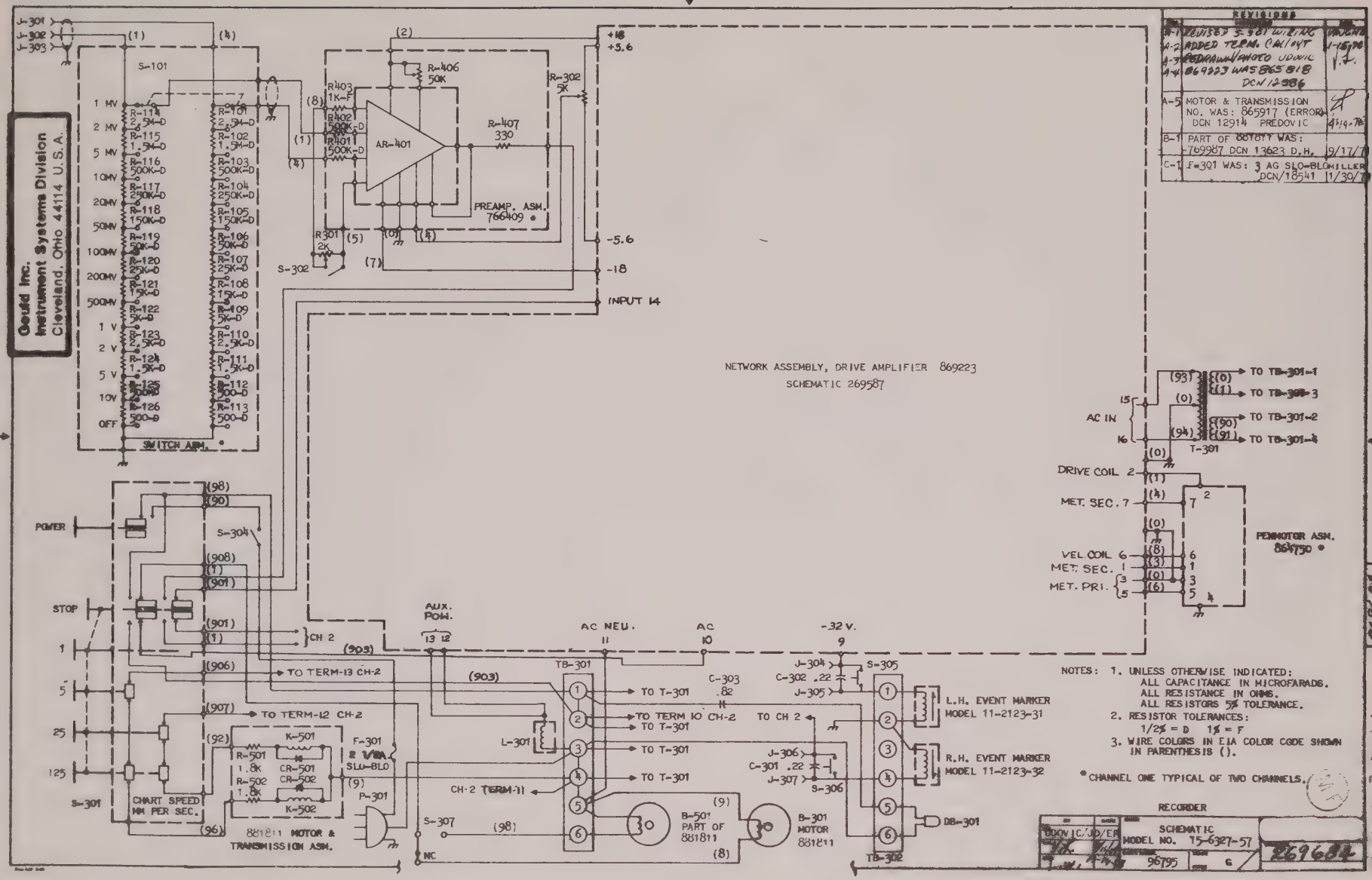
RECORDER
SCHEMATIC
MODEL NO. 75-6327-56
UDOVIC / EH
V.L.
PETRANIC
96795
G
266921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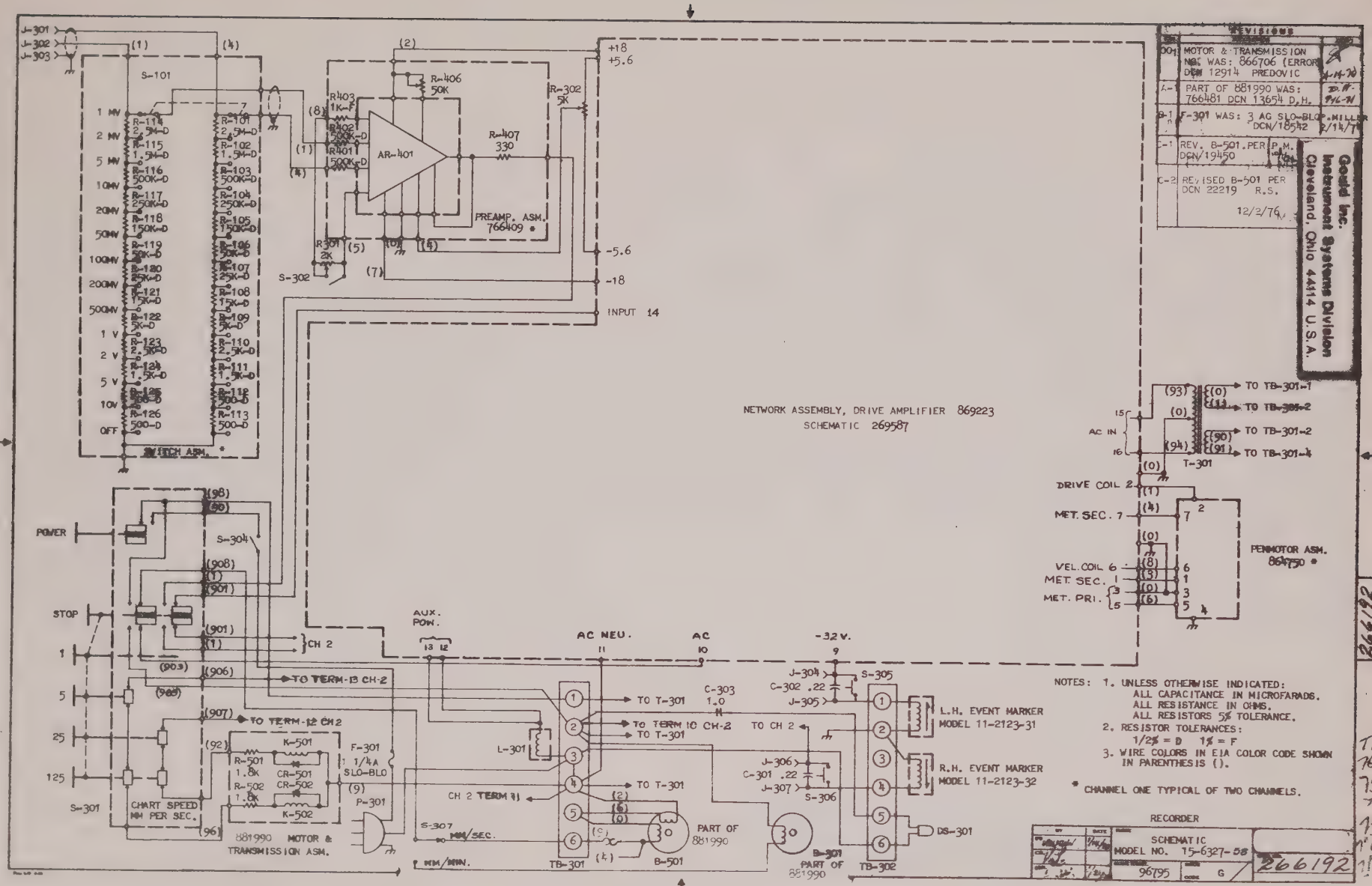
S-101
SWITCH ASM.
1 MV
2 MV
5 MV
10MV
20MV
50MV
100MV
200MV
500MV
1 V
2 V
5 V
10V
OFF
PREAMP. ASM. 766409
AR-401
R-406 50K
R-407 330
R-302 5K
R403 1K-F
R402 500K-D
R401 500K-D
R301 2K
S-302
+18
+5.6
-5.6
-18
INPUT 14
NETWORK ASSEMBLY, DRIVE AMPLIFIER 869223
SCHEMATIC 269587
AC IN
T-301
DRIVE COIL 2
MET. SEC. 7
VEL COIL 6
MET. SEC. 1
MET. PRI. 3 5
PENMOTOR ASM. 867750 *
TO TB-301-1
TO TB-301-3
TO TB-301-2
TO TB-301-4
POWER
S-304
STOP
CH 2
AUX. POW.
AC NEU.
AC
-32 V.
TB-301
TO T-301
TO TERM 10 CH-2
TO CH 2
TO TERM-13 CH-2
TO TERM-12 CH-2
CH-2 TERM-11
C-303 .82
C-302 .22
C-301 .22
J-304
J-305
J-306
J-307
S-305
S-306
L-301
K-501
K-502
R-501 1.8K
R-502 1.8K
CR-501
CR-502
F-301 2 AMP SLO-BLO
P-301
S-307
S-301
CHART SPEED MM PER SEC.
881811 MOTOR & TRANSMISSION ASM.
B-501 PART OF 881811
B-301 MOTOR 881811
L.H. EVENT MARKER MODEL 11-2123-31
R.H. EVENT MARKER MODEL 11-2123-32
DB-301
TB-302
NC
NOTES: 1. UNLESS OTHERWISE INDICATED:
ALL CAPACITANCE IN MICROFARADS.
ALL RESISTANCE IN OHMS.
ALL RESISTORS 5% TOLERANCE.
2. RESISTOR TOLERANCES:
1/2% = D 1% = F
3. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).
* CHANNEL ONE TYPICAL OF TWO CHANNELS.
REVISIONS
A-1 REVISED S-301 W.R.T. ZC
A-2 ADDED TERM. CH1/4T
A-3 REDRAWN/PHOTO JDVIC
A-4 869223 WAS 865818 DCN 12986
A-5 MOTOR & TRANSMISSION NO. WAS: 865917 (ERROR) DCN 12914 PREDOVIC
B-1 PART OF 881811 WAS: 769987 DCN 13623 D.H.
C-1 F-301 WAS: 3 AG SLO-BLO MILLER DCN/18541
RECORDER
DDOVIC/JD/ER
SCHEMATIC
MODEL NO. T5-6327-57
96795
269684



NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL CAPACITANCE IN MICROFARADS.
   ALL RESISTANCE IN OHMS.
   ALL RESISTORS 5% TOLERANCE.
2. RESISTOR TOLERANCES:
   1/2% = D 1% = F
3. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).

* CHANNEL ONE TYPICAL OF TWO CHANNELS.

REVISIONS		
D-0	MOTOR & TRANSMISSION NO. WAS: 866706 (ERROR) DCN 12914 PREDOVIC	1-14-76
A-1	PART OF 881990 WAS: 766481 DCN 13654 D.H.	D.H. 9-16-76
B-1	F-301 WAS: 3 AG SLO-BLO MILLER DCN/18542	12/14/76
C-1	REV. B-501 PER DCN/19450 P.M.	
C-2	REVISED B-501 PER DCN 22219 R.S. 12/2/76	

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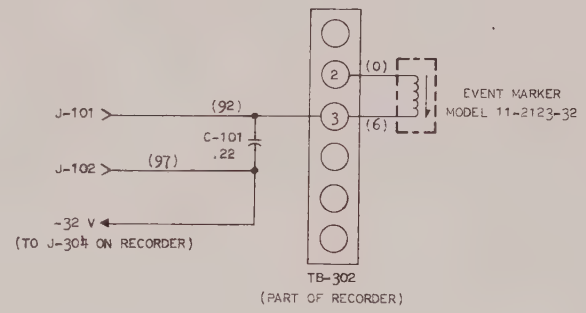
Cleveland, Ohio 44114 U.S.A.

RECORDER
SCHEMATIC
MODEL NO. 15-6327-58
96795 G
266192

REVISIONS		
SYM	DESCRIPTION	DATE
00-2	WAS: (TO J-305 ON REC.) IN ERROR. DCN 13886	11-4-77



NOTES: 1. WIRE COLORS IN EIA CODE SHOWN IN PARENTHESIS ( ).

267224

EVENT MARKER KIT

Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.

BY	DATE
DR FOWLER	EH

SCHEMATIC
MODEL NO. 11-6221-00

CODE IDENT. NO. 96795 | ISSUE CODE G

DWG NO. 267224

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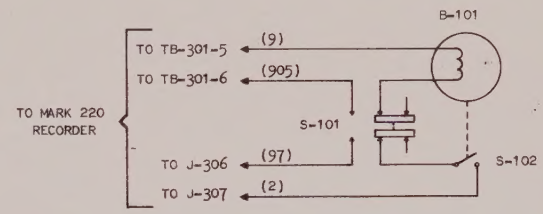
REVISIONS



NOTES: 1. WIRE COLORS IN EIA CODE SHOWN IN PARENTHESIS ( ).

TIMER, 1 SEC.

Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.

BY	DATE
FOWLER/	EH

SCHEMATIC
MODEL NO. 11-6101-21

CODE IDENT. 96795 | SIZE G | DRWG. NO. 267216

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